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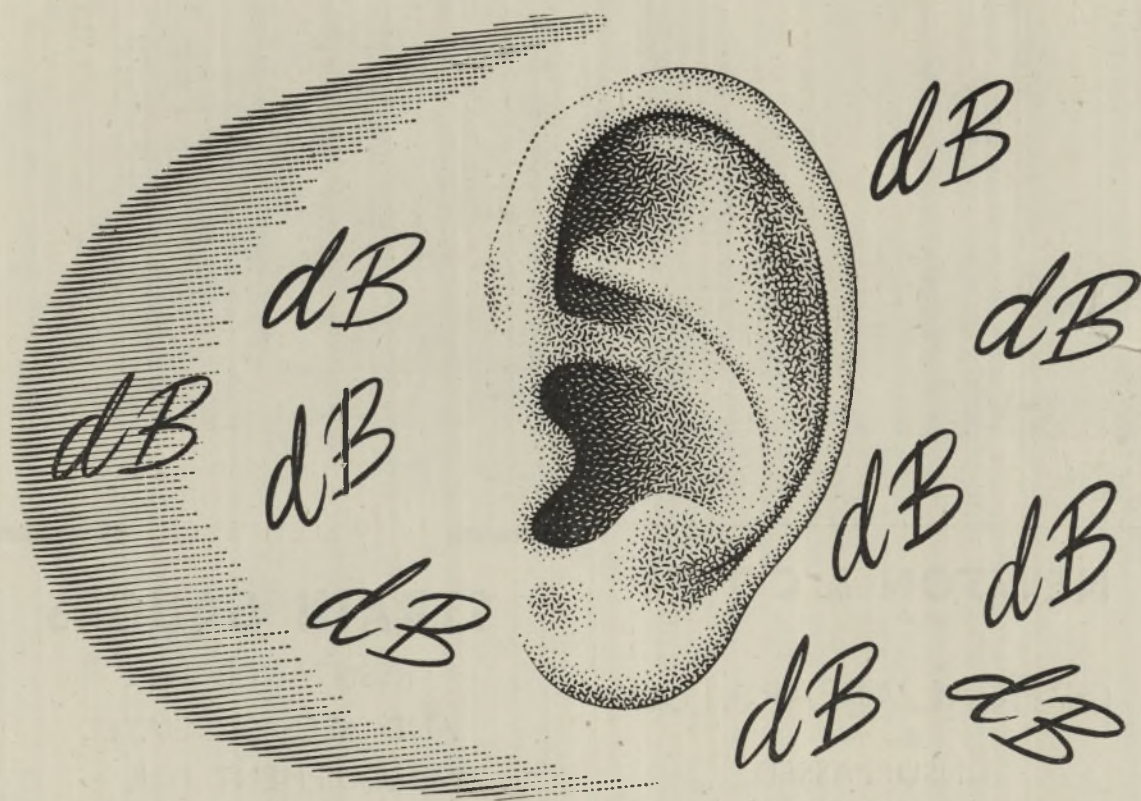
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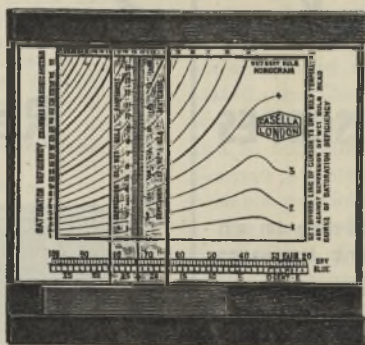
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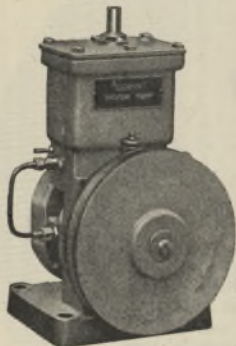
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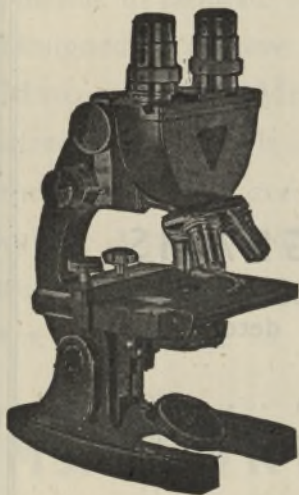
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## SCIENCE AND NATIONAL DEFENCE

NOTHING emerges more clearly from the debate in the House of Lords on May 29 on the control of German war inventions and that on May 30 on the future of directed missiles than the imperative need for a national policy for defence. Without such a policy clearly formulated and rightly aligned with those of the other members of the United Nations organization, there can be no security or world order, or effective prosecution of reconstruction plans. Unless satisfactory answers are forthcoming to some of these difficult questions and an honest effort made to achieve adequate solutions, all our plans for building a world free from fear and want and squalor may fall to the ground. The world organization adumbrated by the United Nations Charter, the control of Germany, and national defence and international security are all interlocked. The allocation of resources, both of materials and of man-power, between the different purposes must be carefully balanced, or mankind may be plunged once more into an armament race and a world war from which there may be no recovery.

There can be no doubt as to the immense importance of the part which science has to play in this question of national defence and of the control of Germany, and scientific workers have no more urgent duty than that of addressing themselves to this problem. It is not a task to be undertaken, however, in isolation from the rest of the community. There must be the fullest and widest possible public understanding of what science and the scientific worker can—and can not—do in this matter. Hence it is of the utmost importance that the report of the committee of scientific men which, Lord Cherwell stated, the Government has appointed to advise on planning our methods for controlling German industry and to consider the whole question of the future of German scientific research, should receive the widest possible publicity.

The two debates were of service in emphasizing the futility of attempting to organize a system of collective security without some reference to developments in new technique and the means of watching and controlling them; they equally emphasized the need for further attention to the formulation of policy. At present, as Lord Cherwell stated, the requirements of the three Services in regard to new weapons are co-ordinated by a fully representative inter-Services committee, and intensive work on longer-term projects is being co-ordinated by a special organization in which all those interested besides the users, technicians and scientific workers from both within and outside the Ministries are represented. What will happen, if and when the Ministry of Supply vanishes, Lord Cherwell could not predict, and it was clear from his speech that no decision has been taken upon the organization of the Services, the continuation of the Ministry of Defence and so on.

These are all questions that should stand above party politics, and on which it should be possible to

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formulate a policy and an organization which would command the support of every party. That point of view and the urgent need for clear thinking on these issues has been further illustrated, since the debate, in the seventh and final report of the Select Committee on National Expenditure for the session 1944-45. One of the main lessons of modern war, it is observed, has been the essential need for maintaining the closest contacts between all three Fighting Services and a fully co-ordinated control over their operations in the field. The necessary corollary to this is the establishment of similar contacts and controls in their supply services and in the basic research upon which these in their turn must rely. Attempts to solve the major problems of administration and government organization involved must lead to reconsideration of the present allocation of departmental responsibilities, and the Select Committee reports its conviction that these problems must be squarely faced and attacked with the least possible delay. It is one of the first questions to which the new Parliament should give its close attention.

The Select Committee's report does not so much indicate the lines on which a solution is to be found as adduce evidence of the dangers of neglect and of the soundness of its conclusion as to the urgency of the whole question. Methods of control and accounting suitable for ordinary administrative expenditure are not necessarily, it points out, those that lead to the most fruitful achievements in research. For that purpose, block grants should be sanctioned for specified periods of years; and parliamentary control of this type of public expenditure may require the development of a new technique.

In addition, there are the further problems of securing the maintenance, both in industry and under government control, of active and fully skilled organizations, with the necessary tools and equipment, for the development of new results flowing from basic research, and for carrying out specific applied research and linking up these establishments, so that the fullest unity of purpose can be maintained between research, manufacture and operational requirements. It is of first importance that the permanent cadre of the armed forces should always have available during peace-time an adequate quantity of the most up-to-date weapons and stores that continuing research and development can provide, not merely for the purpose of training and for use in any war in which the country may become involved, but also because by field experience the fighting man can himself play an important part in the most effective development of war material. This experience should be shared with the Dominions, and the present system for co-ordinating research and design between Great Britain and the Dominions should be continued in peace-time and the Dominions invited to co-operate intimately at all stages.

Without going into details of examples of wasted expenditure, the Select Committee points out that, taken together, such examples show that, at least during the earlier years, the daily cost of the War was unnecessarily increased and the duration prolonged because research had for long been starved, no

adequate steps taken to maintain in peace a nucleus of skilled men which could be rapidly and efficiently expanded for the purposes of war, and because the system of departmental responsibility was insufficiently flexible fully to meet the changed requirements. Critical examination indicates weaknesses inherent in the system and roughness in its machinery, rather than failures in the execution of allotted tasks. These weaknesses should, however, have been foreseen; and now that they are fully recognized, immediate and vigorous action should be taken to put them right.

Maintaining the view which it has consistently upheld, that national economy can be firmly based only on the best outlay of the nation's resources, the Committee has no fears that, if research and development are maintained at a high level and encouraged by the right methods of control and co-ordination, and if the terms of employment offered attract the best brains to the service of the State, the nation's bill for the equipment and maintenance of its forces in a state of fighting efficiency will be disproportionately large. In the long run, uneconomic restriction in research expenditure and failure to evolve means of securing the closest contacts between the scientific worker, the manufacturer and the fighting man must inevitably lead to gross extravagance and perhaps imperil the existence of the nation. It must never be forgotten that owing to a parsimonious attitude to research and consequent unpreparedness, the first two or three years of the War were spent by scientific men and research workers in a strenuous attempt to make up for lost time. Recurrence of these difficulties can only be prevented by securing the technical initiative during the years of peace and welding this to the war potential.

But technical initiative—which the Committee defines as the ability to develop and maintain a technique of maximum weapon-power and to evolve a policy of strategy accordingly—is only one factor in defence policy. Account must also be taken of man-power reserves and economic resources, and the extent to which they can be mobilized in an emergency. Even technical initiative involves having at the service of the State trained scientific men, inventors and manufacturers whose continuing preoccupation with the problems of warfare will render them the more capable of speedily producing antidotes to new and unsuspected enemy devices.

An adequate defence policy, however, involves more than the considerations covered in the Select Committee's report and the establishment of appropriate relations both between departments and between civil and military research. It means also the quantitative and qualitative study of the man-power position of the nation, and a decision on the question as to whether conscription or other form of national service is to be a permanent feature of the national organization. It means decisions as to the size of the armed forces as a whole, and the relative deployment of man-power between them. Moreover, as the War has taught us, it involves making service in the armed forces an attractive career to able and public-spirited youth.

Again, on the production side, besides those qualitative aspects implicit in the observations of the Select Committee, there are quantitative considerations equally important. The quantitative requirements for minimum defence needs will be dictated partly by the decision as to the size of the armed forces to be maintained, which itself will depend in turn on the defence organization established in co-operation with others of the United Nations. Such requirements will also be related to the needs foreseen during the expansion period required to raise production to its war-time level. Nor can a defence policy in its production aspect pretend to be adequate or complete which does not take full account of the shadow-factory principle or that of dispersion. Further, certain industries such as synthetic rubber, high octane fuel, light metals and alloy steels may require special measures to ensure that the production is always in keeping with war-time potential needs and that they are not so located as to be unduly vulnerable to attack. When such problems as shipbuilding, aircraft production, food stocks and production, with all the repercussions which their relation to a defence policy must have upon industrial location and reconstruction and the allocation of man-power are also considered, the imperative necessity for clear thinking on defence and for keeping the issues so far as possible free from all party controversies should be obvious. Only so can the cost of a defence policy which provides the material security, without which social security is impossible, be kept within limits which will not hinder the execution of those measures of social reform and reconstruction on which hopes are so widely fixed.

(To be continued)

## JEWISH PHYSICIANS THROUGH HISTORY

### The Jews and Medicine

Essays. By Prof. Harry Friedenwald. (Publications of the Institute of the History of Medicine, the Johns Hopkins University, First Series: Monographs, Vols. 2 and 3). Vol. 1. Pp. xxiv+390+9 plates. Vol. 2. Pp. ix+391-817+3 plates. (Baltimore, Md.: Johns Hopkins Press; London: Oxford University Press, 1944.) 2 vols., 50s. net.

THE history of the Jewish physician, his role in the development of medicine, science and general culture and his influence on the fate and history of Jewry have not infrequently been the subject of articles, addresses and small monographs. Most of these tend to degenerate into crowded catalogues of eminent medical men who happened to be Jewish by faith or race. The Jewish physician has always been the child of his own age, and though very often highly original and ingenious, was not a creator or exponent of 'Jewish medicine', and this may explain the shortcomings of some of the historical representations which we possess without invalidating the need for comprehensive biographical studies of Jewish medical and scientific men set against the Jewish and general cultural

background of their period. Yet, there certainly is a 'Jewish medicine'—the medicine of the Bible and the Talmud, specifically Jewish in its blending of ritual and hygiene, legal casuistry and medical knowledge. Medicine here emerges as a by-product of the primarily juridical and ritual concerns of the Talmud, and is to a large measure derived from the medical sources and schools of the Greco-Roman culture enveloping Jewish life in Talmudic times in Palestine and elsewhere. Nevertheless it is full of original features which stand out in its best representation, the 'Biblical-Talmudic Medicine', by Julius Preuss (1911), to which one example may be added, the original prescription of sweets for 'Bulmus', that is, ravenous hunger due to a hypoglycæmic condition.

The present work is a collection of essays published, since 1917, by H. Friedenwald, emeritus professor of ophthalmology in the University of Maryland. Without attempting a comprehensive history of the whole subject, its treatment in the form of essays enables the author to exhaust his particular problem and thereby to avoid the mistakes of his predecessors. The love for his subject, documented by fifty years of skilful gathering and studying of a unique collection of pertinent manuscripts, incunabula and books, animates his thorough and scholarly representation, which brings out new points, facts and vistas. Thus his "Bibliography of Ancient Hebrew Medicine" (Essay VIII) adds to that of Preuss many new items from the seventeenth century down to 1942, and is better arranged than any previous classification. Perhaps such a bibliography might be extended to cover even a wider range, including the medical aspects of 'Jewish archæology' (in the sense of Samuel Krauss), Jewish folklore, medical occultism, etc.

In a religious community, medicine has to establish itself. "The best of physicians is fit for hell" is an old Jewish epigram, because physicians are overconfident in their craft and tend to commercialize their profession. According to the Great Rabbi Loew of Prague, 'hell' stands for the material world which the Kabbalah holds to be negation of real existence, that is, the spiritual; the physician as well as the naturalist who knows only the material world will end in hell, that is, in non-existence. But Jewish physicians such as Maimonides were keen naturalists, averse to magic and superstitious practices such as the use of charms, amulets, etc., and the Talmud found subtle and progressive justification for professional medicine as practised by many of its authorities, the Rabbis, which may be read in the author's essay (No. II) on "Judaism and the Medical Art". "The Ethics of the Practice of Medicine from the Jewish Point of View" (Essays III and IV) found remarkable expression in "Apogetic works of Jewish Physicians" (1588, 1631, 1679).

The paramount role of the Jews in the preservation and transmission of Greek and Arabic medicine to the Occident is further illustrated by manuscripts acquired by the author and described in detail, to which a bibliography of medical works in Hebrew is appended (Essays VIII-XI). In the pre-Arabic period (seventh to tenth century A.D.), Hebrew had been used as a literary medium by such writers as Asaph and Donnolo. With the growing need for Arabic and Latin literature felt by Jewish students and physicians, these works were translated into Hebrew. During the Renaissance, humanistic interests account for the use and description of Hebrew anatomical terms by Vesalius and plant-names by Thurneysser, and

for a Hebrew translation of the Hippocratic Aphorisms (Gaiotius 1647; it may be pertinent to add that as late as 1847 such a translation was published in Britain in Young's "Israelitish Gleaner", p. 33). The historian will welcome the lists of Jewish writers in Arabic and of the principal Jewish medical translators and their translations into Hebrew which are appended.

The picture would not be complete without extensive reference to the ordeals and difficulties to which the Jewish medical and scientific men were exposed, and much of this can be found in the biographical essays, especially those dealing with the Marrano physicians, which form the main part of the work under review. What the Jewish medical student had to face in these times is vividly described in "The Jews and the Old Universities". At certain Jewish "Schools" (for example, in Paris and perhaps in Mantua) medicine was taught in Hebrew. These schools rivalled in the fourteenth century the University of Paris, and the medieval universities, which were ecclesiastical throughout Europe, took formal action against Jewish students, though not until after the fifteenth century, and even then degrees were conferred on Jews on special authorization from the Pope. Jews served as distinguished lecturers in Italian universities from the fifteenth century onwards, and at Padua no less than 230 Jews qualified between 1517 and 1721—though not without a remarkable run of artificial difficulties. No such tolerance was practised in Protestant countries (with the exception of Holland). The prominent part played by Jews in the history of Montpellier, which probably owes its foundation to Jewish scholars from Spain, is the subject of a separate essay in which sketches can be found of Prophatius, the Saportas, Nostradamus, Sanchez (the famous sceptic philosopher), and Jean Astruc. The latter (1684–1766), celebrated as the inaugurator of the Elohist-Yahwist theory of Bible criticism and critical defender of the theory of the American origin of syphilis, came from a Spanish-Jewish family, as Friedenwald proves with finality (the fact as such was known before; see, for example, A. Sack, "The Problem of Genealogy of Syphilis". *Aerztliche Mitteil. aus. Baden*, 1932, p. 304).

It is these Spanish-Jewish families of Marranos from which sprung many of the most brilliant scholars and medical men and which, therefore, form the main subject of Friedenwald's biographic and bibliographic studies. Marranos were Jews in Spain and Portugal who were forcibly converted to Christianity, and in many instances continued in secret to practise Jewish ceremonies and transmit the Jewish religion to their descendants. To all familiar with their history it is well known that apparent or real devotion to the Church and high favour enjoyed at the hand of Emperor or Pope is no proof against the Jewish origin of a scholar. This particularly applies to Andres a Laguna (1499–1563), so far only known as one of the greatest physicians of his time and quoted as such by Cervantes, who, as Friedenwald shows, gave in 1555 the *experimental* proof that the root of nightshade causes certain "vain phantasmasgorias" such as are associated with witchcraft, a discovery which enabled Laguna to oppose the age-old views of witchcraft, before Wierus, who is commonly regarded as the first in this field. The setting of this discovery is of particular interest. It occurs in an annotation to Laguna's Spanish translation of the *materia medica* by Dioscorides in the section entitled "Solano". When municipal physician at

Metz in 1545, Laguna, as he tells us, recovered in the hermitage of two wizards (one of whom had been burnt as a witch), a pot with an ointment "that seemed to be composed of the very coldest and soporific herbs; which are the cicuta, the nightshade, the henbane and the mandragore". He used it on the wife of the executioner who suffered from intractable sleeplessness. She fell into a deep sleep from which she was aroused with difficulty after thirty-six hours and related her pleasant sensations during sleep, including cohabitation and "many other strange things", which were ascribed to the "cold" quality of the ointment causing a "frigidity in the diabolical parts from which there comes a humour as cold as ice". Laguna concludes that witches, though deserving of punishment for making a pact with the devil, in reality never leave—neither in spirit nor in body—the spot where they fall asleep. The devil imparts his knowledge of the virtue of such *pharmaka* to the witches, etc. It is noteworthy that the medieval rabbis (Maimonides, Gersonides and others) never believed in the reality of witchcraft, and Amatus Lusitanus as well as Montaigne (the son of a Marrano mother) may have been influenced in their enlightened views towards witchcraft by Laguna.

Space does not permit detailed reference to the many other essays, which include complete historical surveys of the Jewish physicians in Italy, and of Spain, Portugal and south-eastern France, with a complete list (and 67 pages of short biographies) of the Spanish and Portuguese physicians after the expulsion at the end of the fifteenth century, and many individual biographies (notably of Amatus Lusitanus, and his work in the discovery of the venous valves, Montalto, and the eminent physiologist Moritz Schiff (1832–96).

Here, then, is the first comprehensive source book for the history of the Jewish physician, a work indispensable for the student of history in general, Jewish history, the history of medicine and science, and last but not least, for the philosophical observer of human tolerance and of obscurantism. This latter aspect may be illustrated by passages from the essay on Jewish physicians in Spain and Portugal (pp. 614, 618, 647): "During the Moorish supremacy the Jews were among the leaders in the schools of Cordova and Toledo. They enjoyed a period of development in which their studies in science, medicine and philosophy . . . and their poetic productions thrived in so marvelous a manner that it is still described as the Golden Period." . . . "In 1148 . . . the fanatical Almohades conquered the land and the Jews were forced to accept the Muslim faith, their wives and children were sold as slaves and their synagogues and schools were destroyed." In Christian Spain towards the end of the eleventh century, Alfonso VI said: "Jews furnish our vezirs, chancellors and most of our officers . . . and we cannot do without them". But in 1391 a tide of discrimination led to frightful massacres. In Seville the mob killed four thousand Jews, in Cordova two thousand corpses lay in heaps in the streets and in the wrecked synagogues. From Cordova the spirit of murder spread throughout Spain to Aragon, Catalonia, Barcelona and Gerona. These persecutions were the immediate forerunner of the Inquisition.

The work is beautifully illustrated and produced, under the auspices of the Institute of the History of Medicine of the Johns Hopkins University and its director, Henry E. Sigerist, who contributes a preface.

WALTER PAGEL.



## CAUSE AND SENSATION IN PHILOSOPHY

### Proceedings of the Aristotelian Society

New Series, Vol. 44: Containing the Papers read before the Society during the Sixty-fifth Session, 1943-1944. Pp. xxx+160. (London: Harrison and Sons, Ltd., 1944.) 25s. net.

THE nine papers in volume 44 of the *Proceedings of the Aristotelian Society* cover a wide range of subjects, including logic, psychology, ethics, religion. Three are likely to be of special interest to scientific readers. Though the authors approach the subject in different ways and quite independently, they all attack the phenomenalist or positivist view of scientific knowledge. Mr. J. C. Gregory, writing on "Causal Efficacy", argues that those who treat causation as nothing but regularity of succession ignore the universal background of all thinking, primitive or advanced. The notion of activity or efficacy belongs to this background. Dr. J. O. Wisdom in an article on "The Descriptive Interpretation of Science" admits that, so far as it provides a maxim of caution against postulation of unnecessary entities, the descriptive interpretation is useful, but urges that it cannot possibly be taken as final. Experiments are made and experimental science exists only because of the expectation that things will behave in definite ways; an expectation which the descriptive view dismisses as groundless.

Prof. H. H. Price, in his presidential address "Touch and Organic Sensation", clinches the argument with admirable force and lucidity. He points out that phenomenologists and positivists, all those who take the descriptive view of science, the regularity view of causation, and treat matter as a logical construction, are visual philosophers. "Hume looked at his billiard balls. And all that he could see was that one moved whenever the other struck it. Indeed, in any causal transaction there is nothing else to be seen except the concomitance of two events. But the tactual conception of causation is quite different." Organic sensation, if we take it to be the genus of which tactual and muscular sensation are species, reveals a world different from that of visual experience. The difference is specially marked if visual experience is taken, as it so often is, to exclude peripheral vision or anything ill-defined. The first main difference is that organic sensation is better analysed in terms of feeling and content (I feel tired) than of act and datum (I see a cat). The second is that it provides unity or wholeness as well as voluminousness and interpenetration, qualities singularly lacking in sight. As to its different modes, tactual experience gives rise to the obstacular conception of matter and muscular experience to the activity conception of causation. These conceptions do not arise in the first place from inferences made by comparing sets of experiences, but are given as qualities of tactual and muscular sensation. Lastly, muscular activity combined with other forms of organic sense provide a basis for self-consciousness; what it feels like to be alive.

The reason why organic sensation has been neglected and purely visual philosophy so much favoured is that for purposes of theory it is convenient to take sight as the model or type sense. Its range, flexibility and precision make it a specially suitable medium for theoretical statements. Moreover, long before science existed human language had developed

a visual bias in its terminology. The result is that any other sort of perceptual experience tends to be interpreted in visual terms, and often, as Prof. Price argues, misinterpreted. A. D. RITCHIE.

## AMINO-ACID CONSTITUENTS OF PROTEINS

### The Amino Acid Composition of Proteins and Foods

Analytical Methods and Results. By Dr. Richard J. Block and Diana Bolling. Pp. xiv+396. (Springfield, Ill., and Baltimore, Md.: Charles C. Thomas; London: Baillière, Tindall and Cox, 1945.) 6.50 dollars.

AT a time when the world faces a food shortage for man and beast, the nutritive evaluation of protein foodstuffs is a matter of first importance. The relative values of the different proteins in nutrition are based upon their content of those special amino-acids which cannot be synthesized in the animal body and are indispensable for its growth and continued health. All these 'essential' amino-acids are not present in every protein. With a knowledge of the amino-acid composition of the various animal and vegetable proteins, it is possible to choose proteins so that they become mutually supplementary, and thus to ensure a diet that contains the qualitative and quantitative requirements of essential amino-acids.

Obviously the selection of proteins to form an adequate diet depends on accurate estimations of the amino-acid constituents. The analytical methods used in such estimations are scattered widely throughout the literature. It is difficult without much experience to assess the value of several differing methods employed in the estimation of the various amino-acids. Dr. Block and Miss Bolling have collected together analytical methods for the estimation of the essential amino-acids and also of those non-essential amino-acids which can be evaluated with some degree of accuracy. In this way it is possible to compare the content of a specific amino-acid in the same protein as determined by many different procedures.

Attention has been directed to the one great difficulty in any accurate determination of amino-acids in proteins, which is the loss, to a greater or less extent, of the amino-acids by the process of hydrolysis. The methods which have been employed to arrive at an estimate of losses during hydrolysis are discussed in some detail for each of the main groups of amino-acids.

The authors have wisely given the various analytical methods in detail, including not only those employed for determinations but also for separation of specific amino-acids from protein hydrolysates. At the end of each section on a group of amino-acids, they have listed with references the values obtained by different workers for several proteins. Their opinion as to 'best values' may not receive general approval, but it is valuable to have such an opinion based as it is on wide experience.

This book is not only a most timely but also a most welcome addition to the literature of the proteins. It is well indexed and documented with a valuable bibliography. British readers will envy the way in which the book has been produced, with its clear printing on good paper.

### Some British Moths

By Norman Riley. (King Penguin Book.) Pp. ii+30+16 coloured plates. (Harmondsworth and New York: Penguin Books, Ltd., 1944.) 2s.

ALL moths are not clothes moths, nor do all caterpillars eat cabbages, as many laymen still believe. There is much ignorance to dispel, and at the same time a growing appetite for knowledge of wild life to satisfy. This attractively written and produced book should gain both these ends, opening up new fields of pleasure for the man whose garden and now lighted windows attract so many moths, or who takes his leisure in the countryside.

Writing simply but vividly, the author gives an account of the moth's life-history—the various tricks that protect it from its enemies, the marvels of its eyes and organs of touch and smell, how it finds its mate, etc.—that makes fascinating reading. Caterpillars, not merely objects of interest, are shown as living animals with their own problems of concealment and protection, feeding and final transformation.

The forty-six moths illustrated, most of which can easily be found or reared, are necessarily a small selection, but they represent most of the 'macro' families, and the family likenesses are usefully pointed out. Notes on when and where the moths occur and how they live are given. The coloured plates are from drawings by the eighteenth century naturalist Moses Harris, some of which are published for the first time. Their freshness and richness of colour and the life-like attitudes, with larva, pupa and food plant also depicted, make them attractive illustrations. One or two of the smaller figures are perhaps rather blurred for identification purposes.

### The Distribution of the Birds of California

By Joseph Grinnell and Alden H. Miller. (Pacific Coast Avifauna, No. 27.) Pp. 608. (Berkeley, Calif.: Cooper Ornithological Club, 1944.) n.p.

THIS work was commenced by the late Joseph Grinnell in 1934, and before he died in 1939 he had completed about half the species. In 1940 Mr. Alden Miller undertook to finish the volume and, in addition, to revise the typescript already prepared.

Under each species there is a list of synonyms which apply to Californian birds. The information is arranged under three headings: status, geographical range and habitat. The first, in addition to stating whether the bird is common or local, has some remarks on migration. The paragraph dealing with the range of the species gives all the records of distribution over the whole area and any which refer to nesting or occurrences on migration. In every case the authority or reference is added to each record. The final paragraph describes the type of country occupied by the birds during the breeding and non-breeding season. At the end of the book there is a supplementary list of introduced birds and species of uncertain occurrences.

Hence this is solely a detailed record of the distribution of Californian birds, which must have taken an immense amount of labour to compile.

There is no summary or deductions to finish off the work, but at the end of the introduction Mr. Miller states that it is hoped to publish later information dealing with various aspects of Californian bird-life, such as the differentiation centres for races, intrusions of faunas from adjoining continental areas, and other problems. This will be a very valuable contribution, and we shall look forward

to Mr. Miller's additional volume. There is one coloured plate and a number of useful maps showing the distribution of various races.

### Garden Birds

By Phyllis Barclay-Smith. (King Penguin Book.) Pp. ii+30+20 coloured plates. (Harmondsworth and New York: Penguin Books, Ltd., 1945.) 2s.

MANY persons who are not skilled ornithologists take a considerable interest in birds, particularly those that visit their gardens, and they feel the need for a concise, well-written, well-illustrated, inexpensive book to help them recognize their garden inhabitants and visitors. This want has been supplied by Miss Barclay-Smith. She writes of the different types of gardens and the birds likely to be seen in them, of what can be done in the way of planting special trees and bushes to encourage birds, of the plants they like, about deterrent measures against cats, the provision of nesting boxes and how to make them, also the provision of nesting material, and lastly the necessity to supply food and water. Feeders are discussed and the food to be supplied, reference being made to the widespread idea that coco-nut may prove fatal to tits. She says, "it is open to doubt. It is, however, a good thing to spread the nut with lard occasionally to prevent it becoming too hard." The reviewer in pre-war days when coco-nuts were easily obtained always had two or three hung up for the benefit of the tits and never knew a bird any the worse. Miss Barclay-Smith goes on to give individual descriptions of some score of regular garden birds in Britain, her accounts being illustrated by twenty colour reproductions of plates from Gould's "Birds of Great Britain", which are ever vivid and fresh.

F. P.

### Faiths of Many Lands

By E. Royston Pike. Pp. viii+103. (London: Watts and Co., Ltd., 1945.) 8s. 6d. net.

THE world contains many great and interesting religions. To most of us in Great Britain the greater number are merely names. In this unusual little book they become realities, and we read not only of the religions and their founders, but also of the millions who practise these religions, and what effect they have on the lives of the believers. The style is vivid and direct, and certainly arouses interest in the subject.

It is meant for children, but I think it is more suitable for adolescents, or for those who know very little about the subject, and want a simple, interesting introduction to it. It will give many an inclination to go further and read yet more about the Buddhists, the Mohammedans, the Hindus, the Parsees and so forth.

ENID BLYTON.

### Recent Advances in Endocrinology

By Prof. A. T. Cameron. Fifth edition. Pp. vii+415. (London: J. and A. Churchill, Ltd., 1945.) 18s.

THE fifth edition of this book is well up to date. More clinical detail is given here than in previous editions, and this makes the whole more coherent and readable. Among the mass of added material may be found descriptions of the use of 'tagged' atoms in the investigation of thyroid metabolism and of the use of thiouracyl and thiourea in hyperthyroidism. There are some new illustrations and a comprehensive bibliography.

# THERMAL HISTORY OF THE EARTH\*

By DR. E. C. BULLARD, F.R.S.

University of Cambridge

## Observed Temperatures

THE surface temperature of the earth is determined by the balance between the heat received from the sun and that lost to the atmosphere and by radiation into outer space. It is close to the mean air temperature and usually slightly above it.

It has long been known that the temperature underground is higher than this surface value and increases with depth. The rate of increase varies greatly even when volcanic districts are excluded. For example, in the lower part of the Reef-Nigel bore in the Transvaal the gradient is  $7.8^{\circ}\text{C./km.}$ , whereas in a bore at Eakring near Nottingham it is  $54^{\circ}\text{C./km.}$  Even in a single bore it may vary greatly at different depths; for example, in the top 550 ft. of a bore at Holford, in Cheshire, Benfield<sup>1</sup> found a gradient of  $21^{\circ}\text{C./km.}$ , while from 550 ft. to 1,300 ft. the gradient was only  $10^{\circ}\text{C./km.}$  A large part of these variations is due to the varying conductivity of the rocks; for example, the top part of the Holford hole is in marls of mean conductivity  $0.0037\text{ cal./cm. }^{\circ}\text{C.}$ , whereas the lower part is in marl and rock salt of conductivity  $0.0094$ . The heat flow calculated from the product of the gradient and the conductivity is nearly the same at all depths in the hole. The variations in heat flow from place to place are also usually smaller than the variations of temperature gradient.

There is a large body of temperature data, much of which has been taken with great care. Unfortunately, in the absence of information as to the conductivity of the rocks in which the gradients are measured, little use can be made of this abundant material. In the seventies and eighties of the last century a committee of the British Association measured the conductivities of a number of typical rocks. In 1935 a further committee was appointed to investigate the conductivities of specimens from borings where the temperature gradient is known. Thanks to the work of these committees, there are now a number of places in Great Britain<sup>1,2</sup>, South Africa<sup>3</sup> and Persia where the heat flow is known. There is also a determination by Hotchkiss and Ingersoll from a mine in Michigan. The mean results are:

	cal./cm. <sup>2</sup> sec.
Great Britain .. ..	$1.0 \times 10^{-6}$
South Africa .. ..	1.2 "
Michigan .. ..	1.0 "
Persia (provisional value)	1.3 "

The British values probably require to be increased by about 40 per cent to allow for the effects of the ice age. When the ice melted about ten thousand years ago, the surface temperature must have been raised by about  $10^{\circ}\text{C.}$ , and the gradient near the surface will have been initially reversed. This irregularity will have gradually spread downwards and subsided, but after ten thousand years the gradient near the surface will still be less than its equilibrium value. It is probable that a detailed study of the variation of heat flow with depth in a

suitable British bore hole about 3,000 ft. deep would give fairly definite information on climate in the last ten or twenty thousand years. The conditions for satisfactory results are stringent and are not at present satisfied by any bore.

There is surprisingly little difference in the mean heat flows in Britain, South Africa and Persia. In particular, the very low South African temperature gradients do not result from a low heat flow, but are entirely due to the conductivity of the Witwatersrand quartzites being high compared to that of the shales, limestones and marls in which most British temperatures have been measured. The difference in the observed gradients is thus due to economic rather than to geological causes; in England, holes are bored in search of coal, oil or water; in the Transvaal, in search of gold. A South African bore that passes through shales, such as that at Dubbeldevlei, has a temperature gradient similar to those found in England.

The main need at present in this branch of the subject is for more conductivity data, so that the conductivities of the rocks in the numerous bore holes in which reliable temperature measurements have been made can be estimated. Recent American work<sup>4</sup> has made it possible to do this for igneous rocks, and a few hundred more determinations on sedimentary rocks would probably make it possible to estimate the heat flow within 10–20 per cent at a large number of points. Results from the Alps and from other major mountain systems would be of particular interest.

Aside from possible regional variations there are local variations, sometimes reaching a factor of two, between the heat flows measured in individual holes in a single district. Part of these are due to geological structure, that is, to distortion of the lines of flow of heat by departures of the strata from horizontal planes. A salt dome provides an extreme example of this; the high conductivity of the salt relative to the surrounding rocks will cause heat to flow towards it from all sides and will thus increase the heat flow over the dome and decrease it at neighbouring points. Variations due to this cause and to topographic irregularities can be computed or determined from models, and it is desirable that a few cases be investigated in detail in order to determine how far such effects will account for the observed irregularities. Recent denudation and intrusion of salt masses may also cause variation of heat flow. Strong<sup>5</sup> has suggested that these causes have been important in Persia. Anderson<sup>2</sup> has pointed out that high values of the heat flow are observed near the system of tertiary dykes stretching from Mull to Durham. The extent of such disturbances, the magnitude of which it is difficult to estimate, will perhaps be clearer when the direct effects of structure and topography have been more closely investigated.

## Source of Heat

Only about 20 per cent of the observed heat flow can be accounted for by the cooling of the earth from an originally molten state. Kelvin, reversing this argument, showed that an earth in which heat was not generated could not have been solid for more than about twenty million years, and still have a heat flow near the surface as large as at present. The remainder of the heat is presumably derived from the radioactive decay of radium, thorium and potassium. During the last thirty years, much work has been done on the amounts of the radioactive

\* A discussion with this title was held at the Royal Astronomical Society on March 23, 1945. It was opened by the present writer. The principal speakers were Mr. M. W. Strong, Dr. E. M. Anderson, Dr. H. Jeffreys and Mr. G. M. Lees. This article surveys the main points of the discussion and gives some additional comment.

elements present in rocks. The accuracy of the early work has been questioned by Evans<sup>6</sup> and others in America. They have shown that some workers have used incorrect radium standards and that there are other incompletely elucidated sources of error. Unfortunately, the new American work deals only with American rocks, and in considering the world-wide distribution of radioactivity we have no alternative but to use the old results. In 1936 a comparison of all the existing data was made by Jeffreys<sup>7</sup>; this showed a fair degree of consistency and it is possible that many of the data are more accurate than is sometimes supposed. As a general rule, sediments and basic rocks are of low radioactivity compared with acidic rocks. There is a wide variation in the radioactivity of specimens from a single locality, and a variation in the mean from place to place. The distribution is markedly skew and care is necessary in the statistical treatment of the data. A detailed investigation of a number of specimens of granite from an area where the petrology is well known would be of great interest. As granite is much richer in radium than the surrounding sediments, the distribution of radioactivity through the rock might throw some new light on the controversy as to how far granite is formed by crystallization from the molten state and how far by migmatization of sediments.

A cubic centimetre of average granite produces about  $0.5$  to  $1.0 \times 10^{-12}$  cal./sec. The mean heat flow from the earth is about  $1.2 \times 10^{-6}$  cal./cm.<sup>2</sup> sec., of which about 20 per cent may be of non-radioactive origin. The remainder could be produced by 10–20 km. of granite. This result means that the deeper parts of the earth must be almost entirely free from radium, thorium and potassium. If they contained these elements in anything like the same proportions as the surface rocks, the heat would be carried upwards by convection currents and would be conducted to the surface through the solid crust. If the rocks, by some miracle, solidified and stopped the convection currents, the heat would accumulate until melting again took place and the currents restarted. The present value of the heat flow can thus only occur if radioactivity to the extent shown by surface granite is confined to a crust 20–30 km. in thickness. Joly has suggested that there may be alternating periods of melting and solidification, but it is difficult to justify such a hypothesis.

There is some evidence that there is little or no granite under the main ocean basins. If this is so, the radioactive heat generated there may be expected to be less than that generated under the continents. It would be of great interest to verify this by heat flow measurements made under the oceans. There are serious but not necessarily insuperable difficulties in such measurements. The lower radioactivity will cause the temperature at a given depth under the oceans to be less and the density greater than under the continents. Such density differences, occurring at depths where the rocks are hot and probably possess little rigidity against long continued stresses, may cause convection currents moving upwards under the continents and downwards under the oceans. The density variations associated with such convection currents may provide the explanation of widespread fields of gravity anomalies which would otherwise force us to assume that the earth possessed considerable strength to great depths. The surface stresses produced by them may also play an important part in crustal deformation.

The deepest bore so far drilled is about 15,000 ft.

deep. Beneath that, temperatures cannot be directly measured. Reasonable estimates may be made for the outer 30–40 km. by assuming a structure based on seismological results. The main uncertainty is in the vertical distribution of radioactivity. The results indicate that the temperatures are insufficient to melt the rocks anywhere in the crust<sup>8</sup>. This suggests that extensive melting of the crust is only likely to occur in geosynclinal areas where the crust is thickened, or in some other abnormal circumstances.

As the surface heat flow is largely derived from the radioactivity of the crust, it can tell us little about the temperature below the crust. Theoretical estimates are subject to great uncertainty, but calculations have been made on the distribution of temperature to be expected in a globe of molten rock which solidifies and thereafter cools by conduction<sup>9,10</sup>. Conduction only affects the upper five or six hundred kilometres; at this depth a temperature of about 3,000° C. is reached. Below this, the gradient is equal to the rate of increase of melting point with depth due to the increasing pressure; this is probably about 3° C./km. Such a gradient would give a temperature of about 10,000° C. at the outer edge of the core. The gradient in the thoroughly molten metallic core is unlikely to be more than a few tenths of a degree per kilometre, and the temperature attained at the centre will not be greatly in excess of 10,000° C., a temperature much less than that in the interior of a star and almost within the range of laboratory experience.

<sup>1</sup> Benfield, A. E., *Proc. Roy. Soc.*, A, 173, 428 (1939).

<sup>2</sup> Anderson, E. M., *Proc. Roy. Soc. Edin.*, 60, 192 (1940).

<sup>3</sup> Bullard, E. C., *Proc. Roy. Soc.*, A, 173, 474 (1939).

<sup>4</sup> Birch, F., and Clark, H., *Amer. J. Sci.*, 238, 529 and 613 (1940).

<sup>5</sup> Strong, M. W., "Science of Petroleum", 516 (Oxford, 1938).

<sup>6</sup> Evans, R. D., and Goodman, C., *Bull. Geol. Soc. Amer.*, 52, 459 (1941).

<sup>7</sup> Jeffreys, H., *Bei. Geophys.*, 47, 149 (1936).

<sup>8</sup> Holmes, A., "Principles of Physical Geology", 483 (1944).

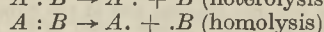
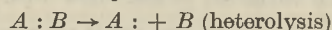
<sup>9</sup> Jeffreys, H., "The Earth", chap. 8 (1929).

<sup>10</sup> Slichter, L. B., *Bull. Geol. Soc. Amer.*, 52, 561 (1941).

## THE NEW ORGANIC CHEMISTRY\*

By DR. D. H. HEY

DEVELOPMENTS in the theory and practice of organic chemistry during the past ten years have opened up a new and broader outlook on organic reactions in general. The reactions of classical organic chemistry, which in the main are concerned with reactions between two molecules or with reactions between an ion and a molecule, have been embraced within a comprehensive electronic theory, the main features of which were firmly established about fifteen years ago. To-day many examples are known of reactions which do not possess the characteristic features of the electronic processes generally referred to as 'electrophilic' or 'nucleophilic', and it is now necessary to consider a third type of reaction, namely, those between a molecule and either an atom or a free radical. Provision for this third type of reaction is obviously necessary, since it is possible to sever a covalent bond in one of two ways, resulting in heterolysis or homolysis, thus:

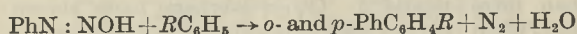


\* Abbreviated from a lecture delivered before the Alembic Club, University of Oxford, on March 5.

The reactions of the free radical triphenylmethyl are well known, and physical chemists have for some considerable time recognized the existence of simple free organic radicals of short life in many gaseous reactions; but the triarylmethyls are highly specialized radicals with which few chemists make contact, and the main and most familiar reactions of organic chemistry, such as are suitable for general laboratory and industrial processes, are not gaseous reactions but reactions in solution which take place within a comparatively narrow range of temperature. The development of the theory of homolytic processes in solution is therefore generally recognized as an advance of considerable importance.

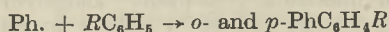
Most text-books refer to the aliphatic hydrocarbons and ethers as inert stable compounds, but it is now necessary to define more clearly what is meant by the word 'inert'. Such compounds are admittedly reasonably inert towards typical anionoid and cationoid reagents, such as acids, alkalis, and the halogens, but this stability does not apply to all reagents. Further, the text-books state that when aliphatic acids or acid halides are mono-chlorinated, the chlorine atom invariably becomes attached to the carbon atom adjacent to the carboxyl group. This, however, is only true for chlorine molecules. If chlorine atoms are involved the halogen becomes attached to the carbon atoms some distance removed from the carboxyl group. Yet again, according to the text-books, a substituent group attached to an aromatic nucleus directs the entry of further substituent groups into specific positions in the molecule. Some groups direct to the *ortho* and *para* positions, while others direct predominantly to the *meta* positions. Such conditions, however, only hold when the substituting agent is of the anionoid or cationoid type. If the substituting agent is a free radical, the laws of aromatic substitution no longer hold and substitution takes place invariably at the *ortho* and *para* positions and in many cases at all three positions. Numerous further examples can be given which indicate to what extent the text-books of to-day require both supplementing and correcting.

The significance of the participation of free radicals of short life in reactions in solution was first brought to light as a result of the study of one or two little-known reactions which could not be accommodated within the accepted electronic theory. Gomberg and Bachmann<sup>1</sup> had shown in 1924 that, when benzene diazohydroxide was allowed to react with a neutral aromatic compound, the laws of aromatic substitution did not hold, and that whatever so-called directing group was present the product was always a mixture of the *ortho* and *para* isomerides, thus:

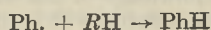


As a result of a study of this and a number of closely related reactions, it was concluded that free radicals were involved<sup>2</sup>, and the fundamental properties of aryl radicals formed under these conditions were then established for the first time<sup>3</sup>. These may be summarized as follows:

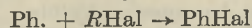
(i) Reaction with aromatic compounds gives *ortho/para* substitution (or in some cases *ortho/meta/para* substitution):



(ii) Reaction with aliphatic hydrogen compounds involves removal of hydrogen:



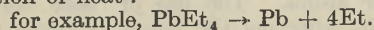
(iii) Reaction with aliphatic halogen compounds involves removal of halogen:



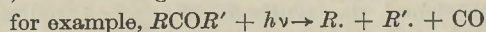
These results led to further work which established the important fact that, contrary to the views of earlier workers, acyl peroxides give rise on thermal decomposition to free radicals<sup>3,4</sup>. This observation provided a satisfactory explanation for the 'peroxide effect' for the abnormal addition of hydrogen bromide, mercaptans, and sodium bisulphite to ethylenic compounds, and led to the widespread use of benzoyl peroxide for the initiation of chain reactions in solution. Further, the use of benzoyl peroxide as a catalyst for addition polymerization falls into line with Staudinger's theory of polymerization; and the recognition of the part played by such peroxides as a source of free radicals has resulted in many fundamental advances in our knowledge of polymerization.

There are at least five different ways in which free radicals of short life can be generated in solution. These may be summarized as follows:

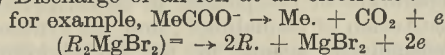
(i) Action of heat:



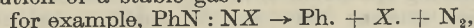
(ii) Action of light:



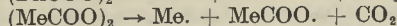
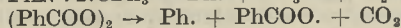
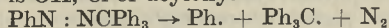
(iii) Discharge of an ion at an electrode:



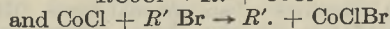
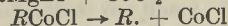
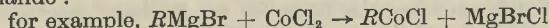
(iv) Irreversible disruption of a molecule with evolution of a stable gas:



where X is OH, Cl or acyloxy.

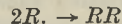


(v) Reaction of Grignard reagents with a metallic halide:

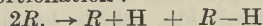


With regard to the properties of free radicals in solution, it is important to recognize (a) that a free radical in solution will not necessarily behave in the same way as would the same free radical in the gaseous state, and (b) that the properties of free radicals, like the properties of molecules, depend primarily on their chemical composition and constitution. In general, a free radical in solution can act in one of three ways, thus:

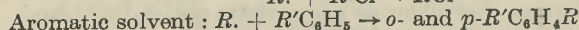
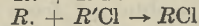
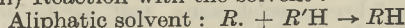
(i) Dimerization:



(ii) Disproportionation:



(iii) Reaction with the solvent:



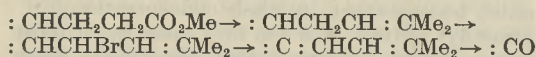
In many cases all three reactions may occur simultaneously, but the relative proportions in which the three types of reaction take place depend mainly on the nature of the radicals themselves and also, but to a much lesser extent, on their concentration.

The methyl radical, like the first member of most homologous series, behaves rather abnormally since it mainly reacts with the solvent. With ethyl, propyl and butyl radicals the disproportionation reaction becomes more prominent, but some reaction with the

solvent also occurs. With the higher alkyl radicals, dimerization becomes the main reaction, and reaction with the solvent becomes negligible. In the cases of radicals with branched chains and hydroaromatic radicals, the main reaction is dimerization. With the benzyl radical, dimerization is again predominant but with longer side-chains attached to the aromatic nucleus, as for example in the  $\beta$ -phenylethyl radical, disproportionation is the main feature. With aryl radicals the predominant and often exclusive reaction is a reaction with the solvent, whether aliphatic or aromatic, and dimerization is very rarely encountered. The effect of concentration is generally to favour the dimerization reaction, as would be expected. When free radicals are formed by the discharge of ions at an electrode, the local concentration of radicals may become momentarily very high, and in these circumstances dimerization may be encountered with radicals, such as phenyl, which in solution normally show no tendency in this direction.

Many examples of interest could be quoted of the practical applications of reactions involving free radicals or atoms. The use of diazo and related reactions for effecting the union of nuclei has been extensively employed<sup>5</sup>. In the medicinal field may be mentioned the synthesis of 1 : 2 : 5 : 6-dibenzofluorene<sup>6</sup>, the important tumour-inhibiting agent, the preparation of compounds in investigations on the constitution of cannabinol<sup>7</sup>, and the synthesis of new spasmolytic agents in the pyridylquinoline series<sup>8</sup>. In the field of colouring matters the reactions for effecting the union of an aromatic nucleus with a pyridine nucleus have led to the preparation of tetrapyrindylphthalocyanines<sup>9</sup>, which, unlike the parent blue pigment, are bright green in colour and can give rise to water-soluble quaternary salts which show affinity for cotton and viscose fibres, thus providing dyestuffs of the phthalocyanine series.

The capacity of benzoyl peroxide to yield free radicals provides the basis for many chain reactions in solution which result in halogenation and carboxylation reactions of an unusual type. Kharasch has shown that in presence of benzoyl peroxide, sulphuryl chloride acts as a chlorinating agent for paraffins, aromatic side-chains and aliphatic acids<sup>10</sup>. These reactions proceed by means of chlorine atoms, and when this method is applied to the fatty acids or acid chlorides it is found that the carbon atoms some distance removed from the carboxyl group are preferentially chlorinated, as opposed to the normal process of  $\alpha$ -chlorination<sup>11</sup>. In an analogous manner oxalyl chloride in presence of benzoyl peroxide can be used as a carboxylating agent for aliphatic and carbocyclic hydrocarbons<sup>12</sup>. Another reagent which is considered to give rise to a neutral halogen atom is N-bromosuccinimide, which brominates at the so-called 'allyl' position<sup>13</sup>. With this reagent *cyclohexene* gives 3-bromocyclohexene, just as 3-chlorocyclohexene is obtained from the reaction between benzene diazo-chloride and *cyclohexene* and 3-phenylcyclohexene is obtained from benzoyl peroxide and *cyclohexene*. A particularly useful application of this reagent is for the degradation of the side-chain in sterols and bile acids, which removes three carbon atoms in one stage, thus :



The application of this series of reactions to 3-hydroxy-cholenic acid has been used in a new synthesis of progesterone, the hormone of the corpus luteum.

The free radical derived by removal of bromine from anethole hydrobromide readily undergoes dimerization with the formation of the dimethyl ether of the valuable synthetic oestrogen hexoestrol<sup>14</sup>. The free radical in this instance was prepared by means of the action of a Grignard reagent on anethole hydrobromide in presence of cobaltous chloride.

In the application of the chemistry of free radicals to the subject of addition polymerization the results have been particularly striking. The generally accepted theory of the mechanism of addition polymerization, put forward by Staudinger in 1936 and since elaborated by others, involves the primary formation of an activated molecule, which then reacts with a second molecule to give an activated dimeride; this in turn reacts successively with further molecules in the same way until finally the active centres disappear, primarily by disproportionation or reaction with a solvent. The initial activated unit and the intermediate units in the building up of the polymer are free radicals. The acceptance of such a free radical mechanism necessarily implies that the polymers so formed should contain fragments of the catalyst, and, if polymerization is carried out in a solvent, fragments of the solvent molecules also. Further, compounds other than acyl peroxides, which are capable of giving rise to free radicals, should also be capable of initiating polymer molecules in the polymer.

The presence of fragments of the catalyst in the molecules of polymers is unmistakably revealed in a number of investigations in which substituted or 'marked' peroxides have been used, containing atoms or groups the presence of which can be readily confirmed by analysis. In the polymerization of styrene in the presence of 3 : 4 : 5-tribromobenzoyl peroxide, the resultant polymer contained 15 per cent bromine, which corresponds approximately to one tribromophenyl group for each polymer chain<sup>15</sup>. It has also been found that polystyrene prepared by polymerization with benzoyl peroxide always contains oxygen, and this has been shown to be due to the presence of benzoate groups, as would be expected from the presence of benzoate radicals. The polymerization of styrene is not accelerated by the presence of a nitrobenzoyl peroxide, and this is attributed to a direct reaction between the free radical and the nitro compound. It had already been established some years earlier that nitro compounds were among the most reactive aromatic compounds towards free radicals<sup>2</sup>. It has also been shown that if styrene is polymerized in presence of nitrobenzene the polystyrene formed contains nitro groups<sup>16</sup>. Nitrothiophene is even more reactive in this respect than nitrobenzene<sup>17</sup>. Other workers have shown that, when polymerization is effected in the presence of carbon tetrachloride, the resultant polymers contain chlorine<sup>18</sup>. These results illustrate the incorporation of fragments of the catalyst and of the solvent molecules in the polymer.

Numerous cases have been recorded of the initiation of addition polymerization by compounds other than acyl peroxides which can decompose to liberate free radicals. For example, polymerization can be effected by means of tetraphenylsuccinonitrile<sup>19</sup>, benzene-azotriphenylmethane<sup>20</sup>, benzene diazohydroxides<sup>21</sup> and nitrosoacylarylamines<sup>22</sup>. These investigations provide convincing evidence in support of the free-radical mechanism of polymerization and add considerably to our knowledge of the subject.

From the above examples it will be evident to

what extent reactions of the type under discussion have now permeated many fields of organic chemistry. The obvious importance of these developments, both from the theoretical and practical points of view, indicates that the time is approaching when it will become necessary to reconsider the manner in which the subject of organic chemistry is presented to the student. In the past the teaching of organic chemistry has been founded to a very large extent on the almost universal and invariable tetravalency of carbon. The newer approach must embrace not only the reactions of the tetravalent carbon molecule but also those of the trivalent carbon radical. It is also pertinent to recall that in the past the raw materials for the organic chemical industry have been derived almost exclusively from coal, but at the present time raw materials are also provided in ever-increasing quantity from the by-products of the petroleum industry. These raw materials, primarily hydrocarbons of various types, are frequently compounds normally regarded as inert, but which are by no means so inert towards reagents which give rise to free radicals or atoms. It is therefore to reactions of this type that we must look in order to develop fully the new resources now placed at our disposal. For these reasons I have chosen to include such reactions, not, it is hoped, entirely without justification, under the title of "The New Organic Chemistry".

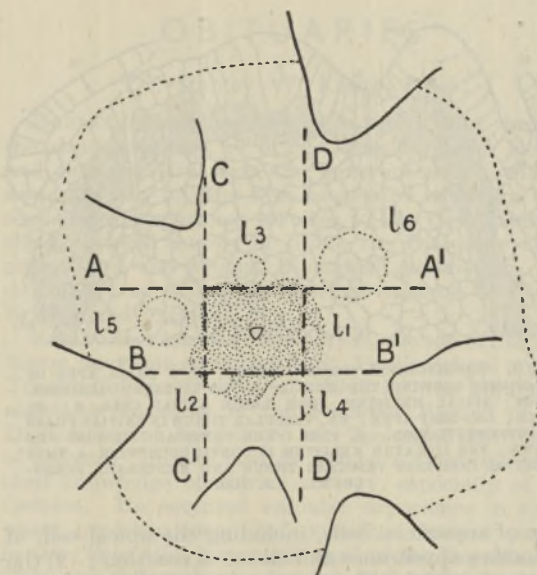


Fig. 1. DOWNWARD VIEW OF A SMALL APEX OF *Dryopteris aristata* SHOWING THE APICAL MERISTEM (STIPPLED) AND A SUCCESSION OF YOUNG LEAF PRIMORDIA ( $l_1, l_2$ , ETC.). THE SYSTEM OF VERTICAL INCISIONS BY WHICH THE APICAL MERISTEM IS ISOLATED FROM ADJACENT LATERAL TISSUES IS INDICATED. ( $\times 54$ ).

meristem—the tissue of which is soft, delicate and readily injured. Thereafter it remained to be seen whether a meristem so treated would prove capable of further growth. The successful outcome of such an experiment seemed likely to throw light on (1) morphogenetic processes at the shoot apex; (2) translocation of nutrients to the shoot apex; that is, whether this takes place by way of the undifferentiated vascular tissue or by upward diffusion over the whole cross-sectional area of the shoot; (3) the factors influencing the differentiation of the vascular system; that is, whether the effective stimuli proceed basipetally from the apex or acropetally from the older pre-formed parts; and (4) the physiological dominance normally exercised by the shoot apex over lateral buds or bud-primordia.

For these experiments the common broad-shield fern *Dryopteris aristata* was selected, plants of all sizes being obtainable in abundance. Previous experience has indicated that this species possesses very considerable vitality under experimental treatment.

An apex of *D. aristata*, as seen in longitudinal median section, may, for convenience, be considered to include three regions in basipetal sequence: (1) the apical meristem which consists of a single

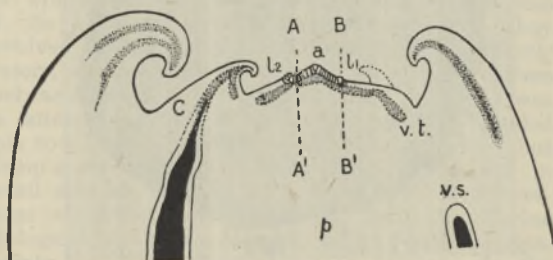


Fig. 2. LONGITUDINAL MEDIAN SECTION OF A LARGE APEX OF *D. aristata* SHOWING THE ISOLATION OF THE APICAL MERISTEM BY VERTICAL INCISIONS. ( $\times 6$ ).

## AN EXPERIMENTAL TREATMENT OF THE APICAL MERISTEM IN FERNS

By PROF. C. W. WARDLAW  
University of Manchester

IN *Dryopteris aristata* an attempt has been made to observe the effect of isolating the apical meristem from the adjacent lateral tissues, while maintaining continuity with the pith parenchyma below. The first step was to ascertain the practicability of the operation. The procedure involves an operation roughly comparable with 'ringing' in an older region of the shoot, in that the incipient vascular tissue is severed. The difficulty lies in the fact that the treatment has to be applied to a minute region—the

- <sup>1</sup> Gomberg and Bachmann, *J. Amer. Chem. Soc.*, **46**, 2339 (1924).
- <sup>2</sup> Grieve and Hey, *J. Chem. Soc.*, 1797 (1934).
- <sup>3</sup> Hey and Waters, *Chem. Reviews*, **21**, 169 (1937). Hey, Annual Reports of the Chemical Society, **37**, 250 (1940).
- <sup>4</sup> Hey, *J. Chem. Soc.*, 1966 (1934).
- <sup>5</sup> "Organic Reactions", **2**, Ch. 6 (John Wiley and Sons, Inc., New York, 1944).
- <sup>6</sup> Swain and Todd, *J. Chem. Soc.*, 674 (1941).
- <sup>7</sup> Ghosh, Pascall and Todd, *J. Chem. Soc.*, 1118 (1940).
- <sup>8</sup> Coates, Cook, Heilbron, Hey, Lambert and Lewis, *J. Chem. Soc.*, 401 (1943).
- <sup>9</sup> Bradbrook, Haworth, Heilbron, Hey and I.C.I., Ltd., U.S.P. 2277629; Haddock and I.C.I., Ltd., B.P.530881.
- <sup>10</sup> Brown, Kharasch and Chao, *J. Amer. Chem. Soc.*, **62**, 3435 (1940).
- <sup>11</sup> Kharasch and Brown, *J. Amer. Chem. Soc.*, **62**, 925 (1940).
- <sup>12</sup> Kharasch and Brown, *J. Amer. Chem. Soc.*, **64**, 329 (1942).
- <sup>13</sup> Ziegler *et al.*, *Annalen*, **551**, 80 (1942).
- <sup>14</sup> Kharasch and Kleiman, *J. Amer. Chem. Soc.*, **65**, 491 (1943).
- <sup>15</sup> Price and Tate, *J. Amer. Chem. Soc.*, **65**, 517 (1943).
- <sup>16</sup> Price and Durham, *J. Amer. Chem. Soc.*, **65**, 757 (1943).
- <sup>17</sup> Price, *J. Amer. Chem. Soc.*, **65**, 2380 (1943).
- <sup>18</sup> Breitenbach and Maschin, *Z. phys. Chem.*, **A**, **187**, 175 (1940).
- <sup>19</sup> Schulz and Wittig, *Naturwiss.*, **27**, 387 (1939).
- <sup>20</sup> Schulz, *Naturwiss.*, **27**, 659 (1939).
- <sup>21</sup> Price and Durham, *J. Amer. Chem. Soc.*, **64**, 2508 (1942).
- <sup>22</sup> Blomquist, Johnson and Sykes, *J. Amer. Chem. Soc.*, **65**, 2446 (1943).

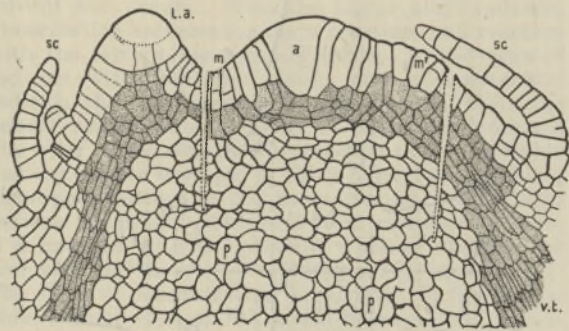


Fig. 3. LONGITUDINAL MEDIAN SECTION OF A SMALL APEX OF *D. aristata* SHOWING THE DETAILS OF AN ISOLATED MERISTEM. *m-m*, APICAL MERISTEM, WITH LARGE APICAL CELL, *a*; *sc*, SCALE; *l.a.*, LEAF APEX; *v.t.*, VASCULAR TISSUE IN INITIAL PHASE OF DIFFERENTIATION; *p*, PITH. THE VERTICAL INCISIONS ARE SHOWN: THE ISOLATED MERISTEM IS CONTINUOUS WITH A THIN SHEET OF INCIDENT VASCULAR TISSUE AND MEDULLARY PARENCHYMA. ( $\times 100$ )

layer of superficial cells, including the apical cell, of distinctive appearance and chemical reaction; (2) the region of initial differentiation, in which leaf primordia, buds and scales originate superficially from cells within or on the margin of the apical meristem and in which stele, cortex and pith can first be distinguished internally; and (3) the region of subsequent differentiation which merges downwards with the fully matured tissue systems. It should be noted that the incipient vascular tissue can be traced upwards to the region of its inception immediately below the apical meristem. Since the principal initial developments take place in region (2), it is there that experimental treatments must be applied.

The first step is to have unimpeded access to the apical meristem. At first sight this does not appear to be a very feasible undertaking. Indeed, because of the large number of rolled leaves and leaf primordia in the terminal bud and the dense investment of scales, the apices of ferns have not generally commended themselves as providing favourable materials for experimental investigations. Nevertheless, it is a fact of experience that there is little difficulty in removing the scales and leaf primordia from stout shoots of *D. aristata* or *D. filix-mas* and thereby laying bare the apical cone. These operations are carried out by means of small pointed scalpels and

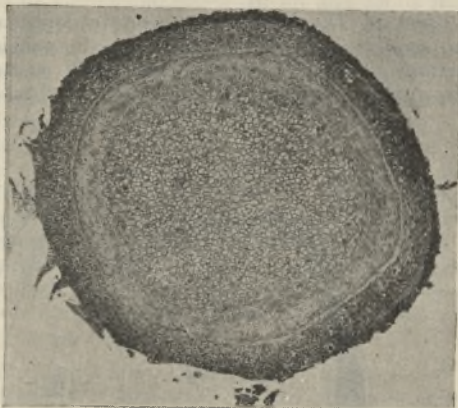


Fig. 4. SOLENOSTELE PRESENT IN THE SHORT AXIS DEVELOPED FROM AN ISOLATED APICAL MERISTEM. ( $\times 20$ .) (Photos 4-7 by E. Ashby.)

forceps, the material being observed under a binocular microscope. A downward view of a small shoot apex is illustrated diagrammatically in Fig. 1.

To isolate the apical meristem from the adjacent lateral tissues, and to sever the incipient vascular tissue, the following procedure was adopted. The terminal region of a stout shoot, trimmed to a length of about 2-3 cm. and defoliated as already described, was observed under a binocular microscope at a magnification of fifty times. By means of a small, thin-bladed scalpel four vertical cuts were made in such a way as to isolate the apical meristem, on a little square island of tissue, as indicated in Fig. 1. In longitudinal section it will be seen that the isolated apical meristem, together with a thin layer of incipient vascular tissue, is seated distally on a plug of developing medullary parenchyma (Figs. 2 and 3).

The system of incisions described above is obviously only one of many that may be applied. For example, the vertical cuts may be made on the margin of the apical meristem, within the margin, or outside it, so as to include one or more leaf primordia, and so on.

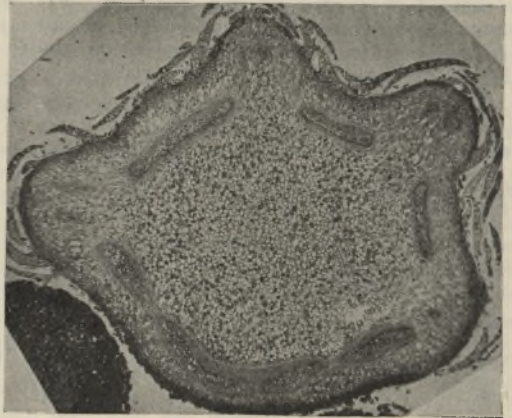


Fig. 5. DICTYOSTELE PRESENT IN THE TERMINAL FOLIAR REGION OF AN AXIS DEVELOPED FROM AN ISOLATED APICAL MERISTEM. ( $\times 11$ .)

Again, leaf primordia of different ages may be isolated on separate plugs. I have found that isolating by four vertical cuts is simple and least damaging to the apical meristem, but other patterns, for example, by three cuts, are also possible. Radial cuts diverging from the margin of the apical meristem have also been made with interesting results. The procedure can be further varied by cutting more or less deeply into the tissue. In passing, it may be noted that the small size of the meristem precludes the use of a cork borer. The experimental and control plants were planted in moist peat in a cool greenhouse.

The isolated meristem is capable of growth. It develops into a short axis and in the course of four weeks may develop three or four new leaf primordia. In the course of three months, one specimen had developed a compact terminal bud in which fourteen leaf primordia were counted. In relation to the severance of the vascular tissue, the lower region of the axis consists entirely of medullary parenchyma. Higher up, a solenostele is present (Fig. 4). Still higher up, in the region of leaf development, the vascular system becomes dictyostelic (Fig. 5). The new leaves in the materials so far examined show normal





Fig. 6. TRANSVERSE SECTION OF A LATERAL SEGMENT OF AN INCISED SHOOT, SHOWING THE LARGE SOLENOSTELE OF A BUD CONJOINED WITH A MERISTELE OF THE PARENT SHOOT. ( $\times 22$ )

phyllotaxis and this is apparently in continuity with that of the parent shoot. Whereas lateral buds develop rapidly on the surrounding segments of the parent shoot, the new terminal axis is devoid of buds.

The lateral segments of the shoot are characterized by the development of very large axillary solenostelic buds (Fig. 6); they are thus in marked contrast to buds on the normal shoot, in which a small, non-medullated protostele is present. Individual undifferentiated meristemes, isolated in lateral plugs as a result of the system of incisions adopted, also show some remarkable and hitherto undescribed developments, such, for example, as the development of solenostelic structure (Fig. 7).

Individual leaf primordia, isolated on plugs, undergo limited development only, and show a tendency to be thrust aside by more strongly growing axillary buds. In contrast to the normal development, in which the foliar conducting system consists of six to eight separate vascular strands disposed horseshoe fashion, the vascular system of an isolated leaf primordium is solenostelic.



Fig. 7. TRANSVERSE SECTION OF A LATERAL SEGMENT OF AN INCISED SHOOT SHOWING THE SOLENOSTELE OF A BUD (TOP) CONJOINED WITH A MERISTELE WHICH HAS BECOME MEDULLATED (CENTRE); THE COMPACT MASS OF TRACHEIDES (BOTTOM) PERTAINS TO A SECOND MERISTELE OF THE PARENT SHOOT. ( $\times 30$ )

Thus, by using the technique described, many new and interesting observations have been made. These will be fully described and discussed elsewhere in due course. The answers to some of the questions raised in the opening paragraph are evident from the data submitted.

## OBITUARIES

Dr. Stanley W. Kemp, F.R.S.

MARINE biology has suffered a heavy blow through the death on May 16 of Dr. Stanley Wells Kemp, and the loss of a wise and generous friend will be deeply felt by all who were associated with him. He rendered distinguished services to the Irish fisheries, the Zoological Survey of India, the Discovery Committee and the Marine Biological Association, and did much to stimulate marine research in Great Britain and overseas.

Kemp was born on June 14, 1882, the son of Stephen Kemp, and was educated at St. Paul's School and at Trinity College, Dublin. In 1903 he was appointed assistant naturalist in the Fisheries Branch of the Department of Agriculture and Technical Instruction of Ireland. In this post he gained a thorough practical knowledge of marine zoology, especially of the Caridea. He acquired valuable experience in deep-water investigations, and published several papers in the "Scientific Investigations" of the Department. This was followed by a period of fourteen years in India (1910-24), where he was first appointed senior assistant superintendent of the Zoological and Anthropological Section of the Indian Museum (which later became the Zoological Survey of India). Here he specialized in the study of Crustacea and began his "Notes on Decapoda in the Indian Museum", a valuable series of publications which continued until 1925. In 1916 he became first superintendent, under Dr. Annandale, of the Zoological Survey, and it is generally recognized that he and Annandale established an exceptionally high standard of zoological research in India. He accompanied various expeditions to study the fauna in different parts of India, including the expedition to the Abor country in 1911-12 (where he discovered the new genus *Typhloperipatus williamsoni*); and in 1922 he carried out the exploration of the Siju Caves in the Garo Hills. In 1916 he was elected a fellow of the Asiatic Society of Bengal, and in 1918 he brought out the important "Catalogue of Scientific Serial Publications in the Principal Libraries of Calcutta". While on leave in the following year, he took the degree of Sc.D. of Trinity College, Dublin, and visited the principal zoological centres in Europe with the view of establishing a marine biological station in the Andaman Islands.

Kemp was appointed director of research to the Discovery Committee in 1924, and it was under his far-sighted leadership that a well-equipped and many-sided organization was built up. The investigations were to include research on the general biology of whales (for purposes of the rational regulation of the whaling industry) and on other natural resources of the Falkland Islands Dependencies, and they involved an oceanographical survey of Antarctic waters, with attention to many subsidiary matters such as surveying and general collecting. This was an enterprise of a new kind which could be guided only to a limited extent by previous experience; but Kemp's remarkable capacity for organization in detail and his mastery of technical problems overcame all difficulties. Early in 1925 the Marine Biological Station was established at South Georgia, mainly for direct observations on whales. In the same year the *Discovery* (Scott's old ship, refitted for oceanographical research) sailed from England and shortly afterwards there followed the *William*

*Scoresby*, designed for whale-marking, experimental trawling, and general oceanography. The *Discovery II* which sailed in 1929 on the first of her five commissions was designed and equipped according to the requirements laid down by Kemp, and after the experience gained in voyages extending over nearly ten years, it would be difficult to devise any major improvements. The high standard he set in everything was also evident in the style of the *Discovery Reports*, of which the first volume appeared in 1929. Kemp sailed in the *Discovery* (1925-27) and *Discovery II* (1929-31) and at other times worked at his headquarters in London. It was under his direction that a new field of research was opened up which has led to much knowledge of whales and related subjects, and of the Southern Ocean in general, and which has in many ways advanced the science of oceanography.

In 1931, Kemp became a fellow of the Royal Society. For a time he was an honorary secretary to the Linnean Society, and in 1936 he received the Victoria Medal of the Royal Geographical Society. It was in 1936 also that he was appointed secretary to the Marine Biological Association and director of the Plymouth Laboratory. Here he found fresh scope for his administrative ability and capacity to stimulate research. He became the leading figure in marine biology, and much as he did to further the interests of the Laboratory, he was in contact also with the *Discovery Committee*, of which he remained a member, and kept in touch with his colleagues in India and Ireland. During the War his advisory activities were of great value, especially in the preparation of post-war investigations, and in this field his opinion carried much weight with the Colonial Fisheries Advisory Committee, the Development Commission, and the English and Scottish Fisheries Departments. He also sponsored investigations on seaweeds which arose from the war-time need for alginic acid.

In 1940 and 1941 the Plymouth Laboratory suffered heavily from enemy action, and though his own home and its contents were wrecked, it was largely through Kemp's personal initiative that the Laboratory was saved from complete destruction. He found safe accommodation for the valuable library, and instituted all possible repairs; and he had worked out comprehensive plans for the alteration and enlargement of the Laboratory in anticipation of peace-time requirements.

He married, in 1913, Agnes, daughter of the Rev. W. Spotswood Green, and had a daughter. In his home life Dr. Kemp enjoyed working with his hands, for he was a fine craftsman, and he found much pleasure as a collector of insect life. He was a man of modest nature with a keen sense of humour; his personality inspired great confidence and respect, and he had a shrewd understanding of human nature and a sense of values which was never led astray by the false or superficial. Those who sought his advice on professional or personal problems were never disappointed, for his judgment was always manifestly sound and sensible. It was an education to work under him, and he will be remembered with gratitude and affection by his many friends.

N. A. MACKINTOSH.

#### Prof. Eugène-Louis Bouvier

It has recently become known in Britain that Prof. E.-L. Bouvier, for many years head of the department of articulate animals at the Musée National d'Histoire

Naturelle de France, and later professor of entomology there, died near Paris on January 14, 1944. He was born on April 9, 1856, joined the Paris Museum in 1883, and remained there for the remainder of his active life, except during the years 1889-95, when he was professor at the School of Pharmacy in Paris. In 1902 he was elected to the Academy of Sciences, and became president in 1925. He received numerous other distinctions both at home and abroad, and was a foreign member of the Linnean Society and the Zoological Society of London.

Bouvier's activities extended over an extraordinarily wide range of subjects. His earlier works include memoirs on Mollusca and Cetacea, and his well-known monograph on *Peripatus*. Shortly after joining the Museum he became especially interested in the Decapod Crustacea, and his researches on this group continued to the end of his life, Bouvier's last work, published in 1942, being devoted to the Crustacea. His monograph on the Atyidae is one of the best-known of his many studies on Crustacea. He also completed a monograph on the Pycnogonida.

While on a visit to Plymouth in 1913, he made the interesting discovery (*Nature*, 91, 633) of the transformation of the Phyllosome larva into the Puerulus stage of the common lobster.

Bouvier first became interested in the habits of insects about 1900, and published studies on the psychology of certain Hymenoptera. In later years he devoted most of his time to entomology, and built up an active department in this subject at the Museum. His general works on the subject include "Habitude et Métamorphoses des Insectes", "Le Communisme chez les Insectes", and "La vie psychique des Insectes", the latter, translated into English by Dr. L. O. Howard, being perhaps his best-known work in Great Britain. After retiring from the Museum, he continued to work on insects and during 1931-38 published six memoirs on the Saturniid moths.

Prof. Bouvier began his active career at a time when evolutionary doctrines were still being contested. He was a student of Edmond Perrier, and as a result of this influence his work was mainly directed to studies on the adaptive evolution of characters in various groups of animals and attempts to elucidate their phylogeny. He was a most enthusiastic research worker and knew how to communicate his interest to others. He became one of the best-known personalities in the scientific world of Paris, and his death removes one of the last links with the great French zoologists of the nineteenth century.

E. HINDLE.

WE regret to announce the following deaths:

Prof. E. Barclay-Smith, emeritus professor of anatomy in the University of London, on July 5, aged eighty-three.

Sir William Ellis, G.B.E., president during 1924-25 of the Iron and Steel Institute and during 1925-26 of the Institution of Civil Engineers, on July 4, aged eighty-four.

Dr. Robert E. Horton, hydraulic consultant to the Tennessee Valley Authority, and a member of the Institution of Civil Engineers, on April 22, aged sixty-nine.

Mr. A. G. Hastings White, C.B.E., honorary consulting librarian to the Royal Society, on July 8, aged eighty-one.

## NEWS and VIEWS

Prof. Major Greenwood, F.R.S.

PROF. MAJOR GREENWOOD'S retirement from the chair of epidemiology and vital statistics in the University of London marks the close of an epoch. Beginning his professional career as a physiologist at the London Hospital Medical College, the study of vital statistics early appealed to him. In addition to making advances in the mathematical study of the subject, he applied his knowledge as a touchstone to medical investigation. As statistician to the Lister Institute and, later, as chairman of the Statistical Committee of the Medical Research Council, his severe and wise scrutiny of data gave medical statistics a new meaning and elevated the standards of research into countless medical problems. During the War of 1914-18, he was in charge of the Medical Research Subsection of the Ministry of Munitions. "The Health of the Industrial Worker", written with Prof. Collis, records much of this work. The London School of Hygiene and Tropical Medicine was fortunate in securing his services in 1926, and he was made a fellow of the Royal Society in 1928. At the London School of Hygiene he soon gathered around him a band of workers trained in his special methods, while his teaching was highly valued by his students.

Prof. Greenwood's investigations with the late Prof. W. W. C. Topley wedded experimental epidemiology to statistical interpretation, and his book on "Epidemics and Crowd Diseases" further enhanced his reputation. The Royal Statistical Society made him its president, and he has enriched its proceedings by many medical and historical papers, which are models of English prose, adorned by wit and incisive epigram. It is not too much to say that Prof. Greenwood's work has revolutionized epidemiology and medical statistics, for he has ever been a searcher after truth and has shattered a multitude of false doctrines which impeded progress. It is satisfactory to know that his pupils—many of whom occupy influential positions—will carry on the torch which he has so successfully kindled. He vacates his chair not only with the regret of all who appreciate his great qualities as pioneer and teacher, but also assured that his work has added considerably to the sum of human knowledge.

Mr. M. A. C. Hinton, F.R.S.

MR. M. A. C. HINTON retired from his position as keeper of the Department of Zoology, British Museum (Natural History) on June 29. He has been associated with the Museum for many years, becoming a voluntary worker in 1910 and an assistant in the Mammal Section in 1921. He was promoted to deputy keeper in 1927 and took charge of the Zoology Department in 1936. His official work has, of necessity, involved most of the mammalian orders, but his principal contributions have been to the knowledge of the Rodentia. Numerous smaller papers, many of them with special reference to the species occurring in the Pleistocene of southern England, culminated in 1926 in the publication of the first volume of his monographic work on "Voles and Lemmings (*Microtinae*) Living and Extinct".

But Mr. Hinton's interests have by no means been restricted to the purely taxonomic aspects of his subject. He has given considerable attention to the economic significance of rodents as enemies of man. His investigations into the musk rat menace in

Britain entailed long, arduous periods in the field both in England and Germany. The order Cetacea has also attracted Mr. Hinton's attention. He prepared the report for the Interdepartmental Committee on Whaling from the papers left by Major Barrett Hamilton, who died while making investigations in South Georgia. This report is the foundation of much that was done eventually to ensure that whaling is carried out in a way least harmful to the stock from which the catches are made. It is hoped that Mr. Hinton, freed from the routine of an official post, will enjoy a long and active retirement, and that it will give him the opportunities he has long sought to concentrate on those zoological problems which, with his great knowledge and experience, he should do so much to elucidate.

Sir D'Arcy Thompson and Oxford

ON June 28, Sir D'Arcy Thompson, professor of natural history in the University of St. Andrews, was awarded the honorary degree of doctor of civil law by the University of Oxford. In presenting him to the vice-chancellor, the public orator (Mr. T. F. Higham) said that science and the classics each claim Sir D'Arcy as their own: as doctor of civil law, Sir D'Arcy will himself now be empowered to settle their rival claims. Mr. Higham also stressed the point that Sir D'Arcy has achieved the distinction, never more to be rivalled, of having been for no less than sixty years a professor. On the evening of the same day, Sir D'Arcy was the guest at a dinner party at which the announcement was made of a presentation volume of essays written in his honour, to be published very shortly by the Clarendon Press. Apart from contributors to the volume, there were present the vice-chancellor, Sir David Ross, Prof. E. S. Goodrich, Sir Henry Tizard, Prof. A. C. Dixon and Mr. Kenneth Sisam; and telegrams of congratulation received from many parts of the world were read.

Aeronautical Engineering at Bristol:

Prof. A. R. Collar

MR. A. R. COLLAR has been appointed to the White chair of aeronautical engineering recently endowed in the University of Bristol by the Bristol Aeroplane Company; he will take up his appointment on his release from national service. Mr. Collar was educated at Simon Langton School, Canterbury, and at Emmanuel College, Cambridge, taking honours in mathematics and physics; he also took an honours degree in physics of the University of London. In 1929 he joined the staff of the Aerodynamics Department of the National Physical Laboratory, where he remained until the beginning of the War, since when he has been specially attached to the staff of the Royal Aircraft Establishment at Farnborough. At Teddington he carried out a wide range of aeronautical investigations, of which those affecting wind-tunnel design and aeroplane flutter problems are probably the most generally known. He is the author of many reports published by the Aeronautical Research Committee, and was for some time secretary of the Airscrew Panel and the Fluid Motion Panel of that Committee. Mr. Collar went to Farnborough to take charge of a special group of scientific men and engineers investigating aeroplane flutter and vibration problems. Working in close contact with aeroplane designing firms, this group has contributed notably to the safety of British aeroplanes.

### New Stratosphere Aircraft

INFORMATION has just been released regarding a twin-engine stratosphere single-seater fighter, the Westland "Welkin", designed to deal with high-flying raiders. It is a mid-wing monoplane of 70 ft. span, weight 17,500 lb., single tail, and generally of conventional aerodynamic form. It is powered by two Rolls-Royce Merlin engines, of 1,650 h.p. each, fitted with two-stage two-speed superchargers sufficient to maintain the power at exceptionally great heights. Rotol four-bladed constant pitch airscrews are used, giving a speed of 385 miles per hour with a range of 1,500 miles. Its armament consists of four cannon, and the pressure cabin is fully armoured.

It is appropriate that this, the first stratosphere fighter to be adopted by the R.A.F. as a standard type, should have been designed and produced by the Westland Aircraft Co., which has specialized in the problem of high flying and was responsible, in pre-war years, for the equipment of the Mount Everest flying expedition. Many problems upon the design of pressure cabins have been solved in the experimental work on the "Welkin" that will be equally important to civil aviation. The automatic regulation of the air pressure is done by a valve developed by the firm, which is already being used on many other aircraft. Cabin heating and the avoiding of ice and mist formation on the windows is done by means of a 'heat sandwich'; warm air is pumped between two layers forming the pressure-resisting surface of the cabin, the same air circulating in the cabin and cockpit space. The temperature control has been found to be such that no special clothing was needed even at an outside temperature of  $-78^{\circ}$  F. At ordinary altitudes, either lower temperature than outside can be maintained or even cooled air can be circulated.

### Geography in New Zealand

DURING recent years the study of geography has won recognition in most of the colleges of the University of New Zealand, and in 1944 a New Zealand Geographical Society was founded in Wellington with branches in the other main cities of the Dominion. This Society has now issued the first number of its journal under the title of the *New Zealand Geographer*, from its publishing office at Canterbury University College, where the idea of the Society was born. The journal, which is to appear twice a year, is to be concerned primarily, but not exclusively, with aspects of New Zealand, and is for home and overseas readers. The first number is devoted entirely to New Zealand topics and is written wholly by New Zealand contributors. Among several important articles is one by Mr. P. D. Sears on the regional variety of pasture growth in New Zealand. Since the country is primarily agricultural with chief interests in grazing, this study of the varying conditions of pasture growth is of much value. Another useful article is by Prof. C. A. Cotton on the geomorphic provinces in New Zealand. The *New Zealand Geographer* is well produced and promises to be a useful addition to geographical serials.

### Bibliography of British Industry

A SELECT Bibliography on "British Industry and Commerce: Its History and Reconstruction" has been issued by the Sheffield City Libraries, to which Lord Riverdale contributes an introduction paying a deserved tribute to the services rendered to industry

in the Sheffield district by the Science and Technology Library of the Sheffield City Libraries. The value of this service is well known to the research workers of the larger firms; but Lord Riverdale points out that Sheffield has in its Central Library one of the most valuable and effective research libraries on iron and steel in Great Britain. The bibliography is not limited to books and pamphlets but includes articles appearing in the more important reviews and scientific or technical periodicals during the last three years. Sections on Government and industry, effects of science and inventions on Society, statistical records, location and planning of industry, industrial research, research and education, British trade and commerce, finance and monetary reform and social security are included, but the bulk of the entries are arranged in the three subsections, history, pre-war organization and reconstruction, under the sectional heading British Industries and Public Services. The only important omission in the history subsection appears to be Sir John Clapham's recently published history of the Bank of England, but the absence of historical records of even large firms is noteworthy. The bibliography is admirably produced and printed; it faithfully reflects the trend of current thought in the fields covered and can be commended as an excellent basis for wider reading and study by those who wish to gain a clearer knowledge of the social and economic background in which scientific and technical research and industrial development proceed.

### Azerbaijan Academy of Sciences

JACOB GIK, writing from Moscow, states that an Academy of Sciences has now been founded in Azerbaijan. Prior to its establishment, the Republic had a branch of the Moscow Academy, with twenty-two research institutes, etc. The new Academy has four main departments: agriculture, biology, geology and chemistry of oil, physics and technology of oil, together with a department of social sciences. The natural resources of Azerbaijan are now well known. Immense oilfields have been discovered and are now being developed. Geologists are investigating deposits of chromite, barytes and cobalt. The efforts of Russian men of science have made the province to a large extent independent of imported materials and enabled industry to carry on its work during the War without serious interruption. Physicists did particularly valuable work during the War. The Institute of Botany has published a comprehensive scientific work: "Agricultural Raw Materials of the Soviet Union". The Institute of Zoology is doing intensive work on problems connected with the effort to increase the yield of cotton, to rationalize the use of winter pasture lands, and to employ suitable local mineral fertilizers. A history of the literature of Azerbaijan from ancient times has just been published in two large volumes. The statutes of the Academy have been approved and fifteen well-known savants have been named as its first members.

### Royal Society of Edinburgh

At the ordinary meeting of the Royal Society of Edinburgh on July 2, Sir William Wright Smith, president, presented to the Society, on behalf of the subscribers, a bronze portrait head, by Benno Schotz, of Sir Edmund Whittaker, president of the Society during 1939-44. A copy will also be presented to Sir Edmund Whittaker. Mr. Stanley Cursiter presented to the Society a copy of his portrait of Sir

William Wright Smith. The Gunning Victoria Jubilee Prize (1940-44) was presented to Prof. H. W. Turnbull, regius professor of mathematics in the University of St. Andrews, and the Makdougall-Brisbane Prize (1942-44) jointly to Prof. Max Born, Tait professor of natural philosophy in the University of Edinburgh, and Dr. H. W. Peng. After the presentations Prof. Sydney Chapman, at the request of the Council and in terms of the Bruce-Preller Lecture Fund, addressed the Society on "The Earth's Magnetism".

#### Blackwell Prize and the Senior Hume Brown Prize in Scottish History

Two scientific workers, well known in the fields of scientific history and social technology, have just been awarded two unusual distinctions. Dr. Archibald Clow, of the Department of Chemistry of the University of Aberdeen, has been awarded the Blackwell Prize for a study of chemical contributions to industrial development. Dr. Clow and his wife, Nan L. Clow, have been carrying out research for several years on the contribution of chemistry to human welfare and development in the era of the industrial revolution, and the manuscript of the book in which they have embodied the results of their researches has been judged an outstanding contribution to history by the University of Edinburgh, which has awarded them the senior Hume Brown Prize in Scottish history. Both authors are graduates in arts and science of the University of Aberdeen, and Mrs. Clow particularly is well known for her contribution to the development of the scientific film society movement. Dr. Clow is a member of council of the Scientific Film Association. Dr. Clow is now working with the B.B.C., where he is taking charge of scientific broadcasts in a new programme to be produced in the early autumn.

#### Awards of the Veterinary Educational Trust

THE Council of the Veterinary Educational Trust has awarded a Senior Wellcome Fellowship for Veterinary Research to Mr. Christopher W. Ottaway. After qualifying in December 1931, Mr. Ottaway was in veterinary practice for three years. He then entered the Anatomy Department, Royal Veterinary College, as a demonstrator and is now senior assistant in the Department. He has worked in the School of Veterinary Anatomy, Leipzig, and in the Department of Anatomy, Brno University Veterinary School, and has published a number of papers on anatomical problems concerned with domestic animals. His research work under the fellowship will be conducted at the Zoological Laboratories, University of Cambridge, and will be concerned with an investigation into the mechanics of the limbs of domestic animals and the factors which predispose to lameness and other diseased conditions.

The Council has also awarded a Wellcome Fellowship for Veterinary Research to Mr. Herbert Williams Smith. Mr. Williams Smith qualified in 1941 and has spent two years in private practice as an assistant. Since 1943 he has been an assistant veterinary investigation officer at the University College of North Wales, Bangor. He has contributed to the technical Press on the examination of milk samples for mastitis, and on the coagulase test for staphylococci. He has recently completed the examination of more than two hundred strains of staphylococci of animal origin with particular reference to determining criteria of pathogenicity. His research under

the award will be concerned with the epidemiology of staphylococcal infections in animals, and will be conducted under Prof. G. S. Wilson at the London School of Hygiene and Tropical Medicine.

#### Conference on Automatic Controlling and Recording of Chemical and Other Processes

THE Institution of Chemical Engineers, the Institute of Physics and the Chemical Engineering Group of the Society of Chemical Industry announce that the one-day joint conference on "Instruments for the Automatic Controlling and Recording of Chemical and Other Processes", which was postponed in September last, will take place at the Royal Institution, London, on October 19, 1945. The purpose of the conference is to promote the interchange of knowledge and experience between those using automatic controllers and recorders in different fields and to encourage collaboration between physicists and chemical engineers. The conference will be open without charge to all interested, whether members of the organizing bodies or not. Further particulars will be sent in September to those sending a request for them to the Organizing Secretary, Joint Conference, c/o the Institution of Chemical Engineers, 56 Victoria Street, London, S.W.1. As there have been so many changes of address, those who previously asked for further particulars are asked to repeat their request.

#### Announcements

SIR LAWRENCE BRAGG is lecturing in Paris at the Sorbonne, under the auspices of the British Council, on "X-Ray Analysis, Past, Present and Future", "The Strength of Metals", and "X-Ray Optics". The visit was arranged in response to a request from French men of science. These lectures conclude a series arranged by the British Council in France since February, but the Council is assisting the British Institute in Paris in making arrangements for future lecturers.

MR. A. L. L. BAKER has been appointed to the University chair of concrete technology tenable at Imperial College of Science and Technology. During the War he has been consultant to the War Office and Admiralty for marine works, and since March 1945 he has been employed in the Chief Scientific Adviser's Division of the Ministry of Works.

DR. E. W. SMITH has been elected president of the Institute of Fuel for the year ending October 1946; this will be his third year of office. Mr. J. F. Ronca, member of Council, has been elected honorary secretary of the Institute.

A BRITISH Medical Exhibition arranged by the British Council was opened at the Sao Jose Hospital in Lisbon last month by the Portuguese Under-Secretary for Education. The Exhibition includes books and instruments, and British medical films have been shown. The Portuguese Minister of Education sent a message paying tribute to the work of the British Council and its institutes in Portugal, and expressing the hope that more such exhibitions would be arranged.

ERRATUM.—The author of the communication "Naga, Naja, Naia or Naya?" published in *Nature* of April 14, p. 457, is W. V. D. Pieris, not "Pieris" as printed; throughout the note, the word 'Sinhalese' should be 'Sinhalese'.

## LETTERS TO THE EDITORS

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

## Animal Learning and Evolution

EVER since the original enunciation by Baldwin<sup>1</sup> in 1896 of the theory of 'organic selection', the suggestion that local differences of habit (local 'traditions' as Elton<sup>2</sup> has termed them) may be the starting point for the evolution of new species of animals has been from time to time put forward in various forms. Such habit 'traditions', if entirely of a phenotypic nature, can of course only exist in animals in which there is some ability and opportunity for perpetuation of a particular type of behaviour or attachment to a particular environment or locality by means of associative conditioning, imprinting, or some other type of learning. Many peculiarities of behaviour which appear to be of this kind are known to naturalists; particularly to those who study such subjects as host selection of phytophagous and parasitic insects or the local variation in behaviour of birds (for example, song, nest-site, feeding habits, etc.). Many examples will be found in recent publications (refs. 3-8). That they may be very constant and persistent is suggested by the fact that, in a number of cases, highly characteristic and constant behaviour patterns of birds (such as song type), usually regarded as typical examples of specific characters, are now known to be, in part at least, transmitted from generation to generation by learning.

But while the idea that certain differences of this kind may be of evolutionary significance has proved attractive to various writers, it has been difficult, without invoking some form of Lamarckism, to visualize the mechanism whereby behavioural differences characteristic of local populations could become genetically fixed. It is true that the Sewall Wright effect might be operative in small populations; but recent criticism by Mather<sup>9</sup> makes the probable significance of the Sewall Wright effect appear less; and in any event Wright's theory, while it might provide for random change, would not of itself favour the genetical fixation of variation of the same kind and in the same direction as the pre-existing behavioural trend based on learning.

Huxley suggests (ref. 6, p. 524) that the organic selection principle might be expected to account for the replacement of non-heritable variations by 'mutations' (presumably merely on account of the increased adaptation to the niche thus conferred), and that "where the modifications are extensive the process of their replacement by mutations may closely simulate Lamarckism". The object of the present communication is to suggest that recent developments in genetics and in the field of animal learning, particularly the concept of imprinting due to Lorenz and others (refs. in Thorpe<sup>4</sup>), make the principle at once more probable and easier to understand.

Mather<sup>9</sup> has pointed out that the kinds of character which are likely to distinguish races and species are polygenic, and that any small decrease in mating freedom between two populations, whether brought about by natural obstacles or by any other cause, will be sufficient to lessen the intensity of selection for good 'relational balance'. The result of this will be that when members of two such populations or

strains cross, the offspring will be heterotic. Mather further brings forward evidence to show that heterotic individuals are often less fit than the parental types, and that the avoidance of heterosis is probably the most widespread stimulant of isolating devices. Such a system, once started, would be self-propagating and irreversible.

Suppose for the sake of argument that the initial basis of separation is a host-plant preference based on olfactory conditioning, or a 'locality imprinting' holding the animal to a restricted locality or environment<sup>4</sup>, renewed afresh in each generation. Suppose also that this is strong enough and has continued long enough significantly to reduce the intensity of selection for relational balance. There will thus be a definite selective advantage for such new variants as favour more complete isolation. Among new germinal variants of equal magnitude, those which are of the same nature and direction as the phenotypic learned response already operating will, besides resulting in closer adaptation to the niche, be the most effective in furthering isolation, and will therefore be most strongly favoured by natural selection. Thus the learned or conditioned response of the animal to the environmental situation will, besides tending to reinforce and make effective slight topographical and geographical barriers, give momentum to, and set the direction for, the selective processes tending to bring about genotypic isolation. These selective processes will thus bring about the reinforcement and perhaps the eventual replacement of non-heritable modifications by genetic modifications, and will thus closely simulate a Lamarckian effect.

W. H. THORPE.

Department of Zoology,  
University,  
Cambridge.  
May 4.

<sup>1</sup> Baldwin, J. M., *Amer. Nat.*, **30**, 441, 536 (1896).

<sup>2</sup> Elton, C., "Animal Ecology and Evolution" (1930).

<sup>3</sup> Thorpe, W. H., "Ecology and the Future of Systematics" in "The New Systematics", ed. J. S. Huxley (1940).

<sup>4</sup> Thorpe, W. H., *Brit. J. Psychol.*, **34**, 66 (1944).

<sup>5</sup> Thorpe, W. H., *J. Animal Ecol.*, in the press (1945).

<sup>6</sup> Huxley, J. S., "Evolution: The Modern Synthesis" (1943).

<sup>7</sup> Mayr, E., "Systematics and the Origin of Species" (1942).

<sup>8</sup> Cushing, J. E., Jr., *Condor*, **46**, 265 (1944).

<sup>9</sup> Mather, K., *Biol. Rev.*, **18**, 32 (1943).

## Inheritance of Melanism in Grey Squirrels

WHILE shooting grey squirrels on the Duke of Bedford's estate at Woburn this spring, some specimens were obtained which throw light on the inheritance of melanism in this species (*Sciurus carolinensis* Gmelin). So far as can be discovered, there is nothing in the literature about this. Nelson<sup>1</sup> states that in some parts of America litters are found to contain a black young; but there is no information on the proportion of black to grey young, or on the colour of the parents.

A grey male and female were shot in March of this year at Woburn, and a litter of four young taken from the drey which they had been occupying. Of these, one was black. If, as seems likely, the adults shot were the parents, they would appear to have been heterozygotes, carrying the factor for melanism, and it may be assumed that a proportion of the young of the normal grey colour were also heterozygotes; thus melanism in this species seems to be recessive and unifactorial.



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Principal: C. A. EDWARDS, D.Sc., F.R.S.

The twenty-sixth Session will open on October 2, 1945

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Entrance scholarships will be offered for competition in April 1946.

Particulars concerning admission to the College, and of the entrance scholarships, may be obtained from the undersigned.

EDWIN DREW,

Singlet'n Park,  
Swansea.

Registrar.

### COMMONWEALTH OF AUSTRALIA

COUNCIL FOR SCIENTIFIC AND INDUSTRIAL RESEARCH

DIVISION OF INDUSTRIAL CHEMISTRY

APPOINTMENT OF RESEARCH OFFICER IN THEORETICAL PHYSICS

Applications are invited for one position of RESEARCH OFFICER, DIVISION OF INDUSTRIAL CHEMISTRY, MELBOURNE.

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Subject to a satisfactory medical examination, the successful applicant will be appointed initially on probation for a period of twelve months, but thereafter, if confirmed in his or her appointment as an officer of the Council, will be eligible to contribute to, and receive benefits from, either the Commonwealth Superannuation Fund or the Commonwealth Provident Fund.

Applications, stating age and nationality, and giving particulars of qualifications and experience, and of present employment, and accompanied by copies of not more than four testimonials, should reach the Secretary, Australian Scientific Research Liaison Office, Australia House, Strand, London, W.C.2, not later than August 11, 1945.

(Signed) G. A. COOK,  
Secretary.

Council for Scientific and  
Industrial Research,  
314 Albert Street,  
East Melbourne, C.2.

### THE UNIVERSITY OF LIVERPOOL

Applications are invited for the post of a full-time Demonstrator in Physiology for Session 1945-46, at a salary of £350 per annum. Further particulars may be obtained from the Registrar.

The University will consider applications from candidates who are still serving in the Forces or are engaged upon other National Service, and leave of absence can be given to a successful candidate until some time after the date of release from the Forces or other National Service.

Applications, giving details of qualifications and career, accompanied by testimonials and/or references, should be forwarded to the undersigned not later than August 31, 1945.

STANLEY DUMBELL,  
Registrar.

### UNIVERSITY OF ST. ANDREWS

The University Court of the University of St. Andrews invites applications for the following two appointments in University College, Dundee:

(a) Lecturer in Mathematics. This Lecturer must have special qualifications in Applied Mathematics and Mathematical Physics. The appointment is for an initial period of five years and may be renewed for subsequent periods. The salary scale is £600 rising by annual increments of £25 to £700 per annum.

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Both Lecturers will require to give, under the supervision of the Professor of Mathematics, courses in Mathematics qualifying for Graduation in Arts and Science (including Engineering). Further particulars of the appointments may be obtained from the undersigned with whom applications should be lodged not later than August 18. Candidates are asked to state when they would be able to take up duty if appointed.

DAVID J. B. RITCHIE,  
Secretary.

The University,  
St. Andrews.

### UNIVERSITY OF ST. ANDREWS

The University Court of the University of St. Andrews invites applications for appointment as Assistant in Zoology in the United College, St. Andrews. The initial salary is £300 per annum rising by two annual increments of £25 to £350, and the appointment is for a period of three years. Applications should be lodged with the undersigned not later than August 18.

DAVID J. B. RITCHIE,  
Secretary.

The University,  
St. Andrews.

### THE UNIVERSITY OF LIVERPOOL

The Council invites applications for two posts in the Department of Zoology.

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2. Lecturer (salary £350 per annum) to assist in the general teaching of Zoology.

The appointments will be made in the first instance for one year. Applications, together with three testimonials, should be forwarded not later than September 19, 1945, to the undersigned, from whom further particulars may be obtained. Service candidates may apply by air mail to be followed by full application later.

STANLEY DUMBELL,  
Registrar.

### ANGLO-AMERICAN STUDENT-SHIP

It is proposed to consider applications for the Anglo-American Studentship in July 1945.

These studentships will normally be awarded for one year, but may be renewed for a second year, the value of the award being £225 for the first year and £250 for the second year, if renewed. The Studentship is open to graduates of the University of Birmingham and science graduates of other Universities. The object of these Studentships is to encourage research in some branch of petroleum technology and normally the holder will be expected to devote his whole time to research in the Department of Oil Engineering and Refining.

The holder of the Studentship will not be required to pay tuition fees or expenses incurred in connection with the research. The holder may proceed to a higher degree in accordance with the regulations of the University of Birmingham.

Applications for the Studentship, which should include a statement of age, academic qualifications and career, should be submitted to the Registrar of the University of Birmingham by July 30, 1945. Applicants must also submit the names of two referees.

### UNIVERSITY OF EDINBURGH

Applications are invited for the post of Lecturer in Chemistry. Candidates should have a Ph.D. Degree with research experience in inorganic or physical Chemistry.

The appointment will date for three years from October 1, 1945, at a salary of £425 with annual increments of £25.

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W. A. FLEMING,  
Secretary to the University.

### WIGAN AND DISTRICT MINING AND TECHNICAL COLLEGE

The Governing Body invites applications for the full-time post of LIBRARIAN rendered vacant by the resignation of Miss C. E. L. Land, M.A., F.L.A. Duties to commence October 1, 1945.

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Further particulars and application form will be sent by the undersigned on receipt of stamps value 5d. Last date for the receipt of applications July 24, 1945.

J. F. S. ROSS,  
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The conditions of appointment may be obtained from the undersigned.

H. J. BUTCHART,  
Secretary.

The University,  
Aberdeen.

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F. A. HUGHES,  
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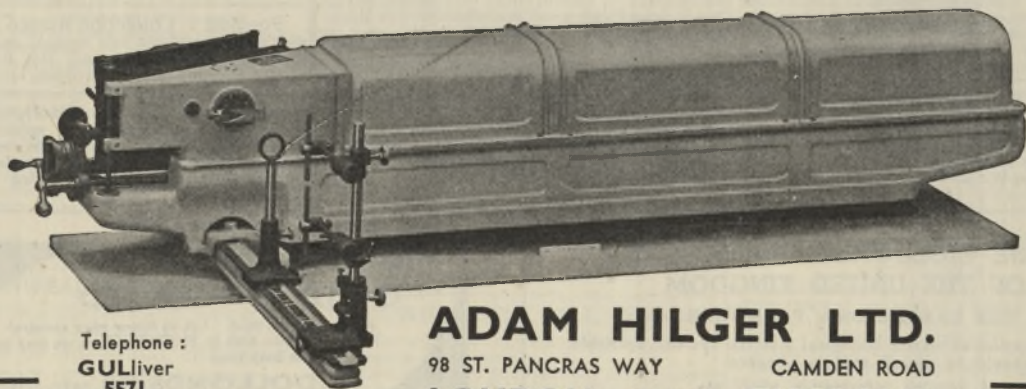
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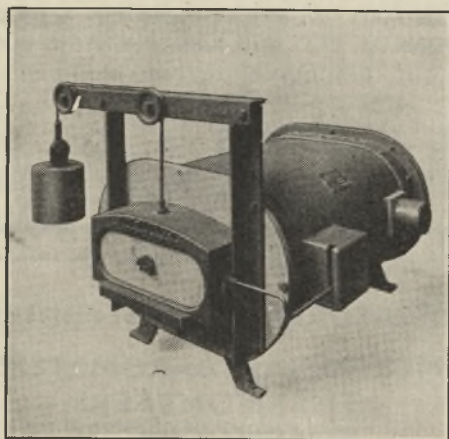


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Another drey about half a mile away, in the same wood, was found to contain a black female suckling a single black young one.

Grey squirrels were first introduced into Woburn by the late Duke of Bedford in 1890. The black phase was introduced later, but unfortunately there is no record of the numbers involved, nor of the locality from which the introduction was made.

Melanic grey squirrels have been recorded from Ontario, the Alleghenies of Pennsylvania, New Brunswick, Michigan and Minnesota. They are stated to occur locally, and to be confined to narrow limits. All these areas are included in the range of one sub-species of *Sciurus carolinensis*, namely, *carolinensis leucotis* Gapper. It is possible that the melanism occurs only in this sub-species; in which case the grey squirrel population of Great Britain includes the *leucotis* form. In Great Britain melanics are found also at Ashwell and Northchurch in Hertfordshire<sup>2</sup>.

The Continental red squirrel (*Sciurus vulgaris* L.) has a melanic form, which has been noted in large numbers in many parts of its range. Neither case has been analysed genetically.

A degree of variation is found in the melanic forms of both species. Melanic grey squirrels were found with brown underparts, or with the hairs of the back tipped with brown. One specimen had a streak of white on the belly. The saturation of melanism appears to be slight enough to be affected by variation of the rest of the gene complex.

Dr. E. B. Ford, of the Department of Zoology and Comparative Anatomy, University of Oxford, and Mr. C. Elton, director of this Bureau, kindly gave advice in this matter. The Duke of Bedford was asked for details of the introductions into Woburn.

MONICA SHORTEN.

Bureau of Animal Population,  
University Museum,  
Oxford.  
May 1.

<sup>1</sup> Nelson, E. W., *Nat. Geog. Mag.*, 33, 371 (1918).

<sup>2</sup> *Trans. Herts Nat. Hist. Soc. Field Club*, 22, 53.

## Heterokaryosis and the Mating-Type Factors in *Neurospora*

EXPERIMENTS on the production of heterokaryosis in *Neurospora* have disclosed a striking difference, in the relationship of mating type to heterokaryosis, between the homothallic species *N. tetrasperma* and the heterothallic species *N. Crassa*.

Hansen and Smith<sup>1</sup> have demonstrated the occurrence of heterokaryosis, that is, the presence of genetically different nuclei within individual cells of a mycelium, in Fungi Imperfecti. More recently this phenomenon has been discovered and investigated in *Neurospora*<sup>2,3,4</sup>.

The heterothallic species *N. crassa* and *N. sitophila* each consist of two mating types which are separated at the time of ascospore formation. Single ascospore cultures only produce functional perithecia when brought into contact with cultures of the different mating type. *N. tetrasperma* also possesses two mating types; but in this species, the ascospore is bi-nucleate

at its inception, one nucleus containing one of the mating-type or incompatibility factors, the second nucleus containing the opposite factor. A single ascospore culture is therefore heterokaryotic and self-fertile. Homokaryotic lines can be obtained, however, which contain only one or other of the mating-type factors and which do not form functional perithecia unless brought into contact with the different mating-type<sup>5</sup>. Dodge<sup>3</sup> found that, when a certain homokaryotic race of dwarf habit was combined with another race of poor vigour, a heterokaryon was produced showing much greater vegetative vigour than either of the parent races. This occurred whether the second race was of the same or different mating type from the original dwarf.

Beadle and Coonrad<sup>4</sup>, working chiefly with mutants of *N. crassa* characterized by their inability to grow well in the absence of certain specific chemical compounds, obtained similar results. When two such deficient mutants were combined, they produced a heterokaryon which was able to grow at the normal rate in the absence of the substances required by the individual lines. There is thus a 'dominance' effect of the normal allele in one nucleus over the mutant allele in the other. These results, however, were obtained only when mutants of the same mating type were combined. Beadle and Coonrad suggest that the absence of this vegetative vigour when mutants of different mating type are combined is due to the tendency of such combinations to form perithecia rather than to grow in a vegetative manner.

Using mutants derived from the fluffy strain of *N. crassa*, I have made many such combinations, using mutants characterized by reduced vigour. In most instances, when the two components belong to the same mating type, a heterokaryon is produced approaching and often equalling the standard fluffy type in vigour. When the mutants are of different mating types, the two mycelia grow side by side or the more vigorous overgrows the other, without any evidence of heterokaryosis whatever. All attempts so far to obtain evidence of heterokaryosis involving nuclei of the two different mating types (which will be described elsewhere) have failed. It is not yet known whether the fusion of hyphae containing such nuclei is inhibited or whether such fusion occurs but without the two types of nuclei becoming associated.

These results are taken to indicate that the association of nuclei of different mating types occurs at the time of sexual reproduction and not by fusion of vegetative hyphae.

The difference between a homothallic species such as *N. tetrasperma* and a heterothallic species such as *N. crassa* appears to be that, in the former, nuclei containing the mating-type factors are attracted at all stages in their life-history, whereas in the latter they are repelled or kept apart until the time of sexual reproduction, as suggested by Dodge<sup>6</sup>.

EVA SANSOME.

Department of Cryptogamic Botany,  
University, Manchester.

May 23.

<sup>1</sup> Hansen, H. N., and Smith, R. E., *Phytopath.*, 22, 953 (1932).

<sup>2</sup> Lindgren, C. C., *J. Genet.*, 28, 425 (1934).

<sup>3</sup> Dodge, B. O., *Bull. Torrey Bot. Club*, 69, 75 (1942).

<sup>4</sup> Beadle, G. W., and Coonrad, V. L., *Genetics*, 29, 291 (1944).

<sup>5</sup> Dodge, B. O., *Mycologia*, 20, 226 (1928).

<sup>6</sup> Dodge, B. O., *Mycologia*, 27, 418 (1935).

### Bionomics of *Hylemyia cinerella* Fallen

A REVIEW of literature reveals that no account has been given on the bionomics of this species in Egypt. It is frequently met with during the spring and autumn; and the average person would be likely to take it for a small house-fly. It is a coprophagous species. It breeds in cow- and buffalo-dung and in human excrement, but the former is much preferred by the fly as a breeding medium. Experiments show that horse manure does not attract the female fly for oviposition. This fly was reared from human faeces by Howard<sup>1</sup>. Other coprophagous species of *Hylemyia* (*H. longicornis* and *H. strigosa*) have been reared from cow- and horse-dung<sup>2</sup>.

The breeding season of *H. cinerella* is the spring (March and April) and the autumn (September). On March 4, 1944, three hundred third-stage larvæ were collected from buffalo-dung exposed in the open. These larvæ were transferred to the laboratory and each was placed in a tube with a small quantity of dung and the tube covered with muslin. The larvæ were left to metamorphose and were kept under observation. A few drops of water were added to the dung whenever it showed signs of becoming dry. It was found that the larvæ took three to four days to change to pupæ, and these were transformed to adults in about seven days. The temperature during metamorphosis was about 25°C.

M. HAFEZ.

Department of Entomology,  
Faculty of Science,  
Fouad I University,  
Abbassia, Cairo.

<sup>1</sup> Howard, L. O., *Proc. Wash. Acad. Sci.*, **2**, 583 (1900).

<sup>2</sup> Séguy, S., "Faune de France, Diptères, Anthomyides", 81 (1923).

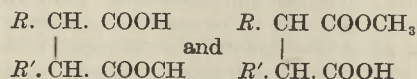
### Inhibitory Action of Dialkyl Succinic Acid Derivatives on the Growth *in vitro* of Acid-fast Bacteria

THE elucidation, by Shriner and Adams<sup>1</sup>, of the structures of the well-known leprocidal compounds, chaulmoogric and hydnocarpic acids, and the isolation, by Anderson and his co-workers<sup>2</sup>, of tuberculostearic and phthioic acids, from the lipid fraction of tubercle and other acid-fast bacilli, has stimulated synthesis of various branched-chain fatty acids by a number of workers. Of the large number of these acids synthesized by Adams *et al.*<sup>3</sup>, the disubstituted acetic acids containing 16-18 carbon atoms were found to be most active against the leprosy bacillus *in vitro*. Adams's most active acid against the tubercle bacillus inhibited the growth of the latter in a dilution of 1/50,000<sup>3</sup>. Robinson and Birch<sup>4</sup> have synthesized a number of trisubstituted acetic acids having two long-chains and have found these acids to possess marked physiological activity resembling that of phthioic acid, producing cell reactions in animals as well as being strongly inhibitory of the growth of the tubercle bacillus *in vitro*.

The late Prof. T. J. Nolan suggested to one of us that roccellic acid, a product isolated from the lichen *Lecanora sordida*, having a branched structure, might be inhibitory of the growth of mycobacteria. This acid is a disubstituted succinic acid having the structure  $\alpha$ -methyl- $\alpha'$ -*n*-dodecyl succinic acid<sup>5</sup>. It proved, however, to be only weakly inhibitory *in vitro* against *Myc. phlei* and *Myc. tuberculosis*

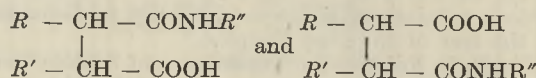
(*bovis*). This was in agreement with the findings of Adams relative to  $\alpha$ -butyl- $\alpha'$ -cyclohexyl ethyl succinic acid. No significant increase in antibacterial activity was noted by us with other dialkylated succinic acids; for example,  $\alpha$ -methyl- $\alpha'$ -*n*-hexadecyl,  $\alpha$ - $\alpha'$ -di-*n*-heptyl succinic acids.

When, however, a methyl alcoholic solution of the anhydride of any of the above acids is neutralized with dilute alkali, only one equivalent of alkali is taken up and the neutral solution contains a mixture of the isomeric monomethyl esters:



A solution prepared in this way inhibits the growth of the routine organisms, *Myc. phlei*, *Myc. smegmatis* and *Myc. Rabinowitz* at a dilution of 1/20,000-1/40,000 of the monoester for six days (the duration of the experiment) and *Myc. tuberculosis (bovis)* at a dilution of 1/200,000-1/400,000 for 6-9 weeks when certain succinic anhydrides are used. The employment of other alcohols in the production of the half-esters has shown that on the whole no improvement in antibacterial effectiveness may be looked for in that direction.

The cloaking of one of the -COOH groupings was also effected by preparing mixed monoanilides of the type



where  $R''NH_2$  represents a wide variety of amino-compounds, such as *p*-aminobenzene sulphonamide, *p*-aminobenzoic ester, aniline, 2-aminothiazole, etc. The inhibitory action of these compounds is of the same order as that of the half-esters but generally somewhat weaker.

All these active substances are strongly hæmolytic, bringing about the laking of washed human red blood cells in 30 minutes at a dilution of 1/50,000 on the average. Incorporating in the solution one eighth of its volume of human serum reduces the hæmolytic dilution to 1/2,000. Unfortunately, it was found that the antibacterial activity of the solution also was now weakened to a similar extent. Preliminary experiments indicate that the globulin fraction of the serum is responsible for the antagonism. It is generally assumed that an antibacterial substance which is strongly antagonized *in vitro* by serum or a tissue extract will prove ineffective *in vivo*. With a pathogen which grows so slowly as *Myc. tuberculosis*, it may, however, be possible to obtain a concentration of unadsorbed drug sufficient to retard at least the growth of the organism *in vivo*. As investigated so far, these drugs do not appear to be extremely toxic when injected intramuscularly into guinea pigs. Animal protection experiments are now in progress and the results will be published in due course.

Synthesis of other acids is proceeding, but present indications are that the molecular weight of the acid, or alternatively the total number of carbon atoms in the two substituents, must lie within a definite range to produce maximum tuberculocidal activity in the half-ester. Furthermore, with a definite molecular weight, maximum activity is reached when the two substituents are of equal magnitude.

Thus  $\alpha$ -ethyl- $\alpha'$ -dodecyl succinic monomethyl ester inhibits *Myc. tuberculosis (bovis) in vitro* for six

weeks at 1/400,000, while the isomeric  $\alpha$ - $\alpha'$ -di-*n*-heptyl acid ester inhibits for three to four weeks at 1/800,000–1/1,000,000 and for six weeks at 1/300,000. The strain used in these experiments was from the National Collection of Type Cultures (No. 46) and was grown on ordinary nutrient peptone broth.

These drugs inhibit the growth of *Staphylococcus aureus* at 1/20,000 and *C. diphtheriae (mitis)* at 1/40,000 *in vitro*. They do not affect the growth of *Bact. Coli* or of *Aerobacter aerogenes* at 1/1,000.

We are indebted for fellowships to the Medical Research Council of Ireland, which financed this investigation.

VINCENT C. BARRY.

University College,  
Dublin.

Trinity College,  
Dublin.

P. A. McNALLY.

<sup>1</sup> *J. Amer. Chem. Soc.*, **47**, 2727 (1925).

<sup>2</sup> *Phys. Rev.*, **12**, 166 (1932).

<sup>3</sup> *J. Pharm. and Expt. Ther.*, **45**, 121 (1932).

<sup>4</sup> *J. Chem. Soc.*, 505 (1940).

<sup>5</sup> *Sci. Proc. Roy. Dub. Soc.*, N.S., **21**, 557 (1937).

### 'Fissibactericidal' Nature of Penicillin Action

WORK reported in several recent papers<sup>1,2</sup> has verified the bactericidal mode of action of penicillin on certain bacteria. The most important point brought out in these publications is that penicillin works preferentially, or solely at low concentrations, on those bacteria in the growth phase or undergoing actual fission.

Just as it was logical for one to search for antibacterial substances produced by various micro-organisms grown in the presence of bacteria, it seems logical that some of the moulds or other micro-organisms thus growing and competing with any bacteria present for the available food supply should finally become able to produce and secrete substances which are active in low concentration upon rapidly growing bacteria. The 'invading' bacteria would be of no immediate importance to such micro-organisms unless they were actively growing, since the latter would not have to share with them the food commonly available. This manner of action, which has been proved to exist *in vitro* for *S. aureus*, should it also be present in Nature, would offer a way of survival for the bacterial species in question, since any change in conditions which of itself would arrest active fission of the 'invading' bacteria would render them unsusceptible to the antibacterial action of the penicillin-like secretion.

This above discussion must for the present be limited to penicillin, since the process has been proved for this substance only. The concept, however, is thought to be of more general interest and application and is pointed out for this reason.

It is felt that a new word is needed to describe the particular kind of bactericidal action discussed here, and typified by the action of penicillin on susceptible organisms (*S. aureus*). This word must mean an agent which kills bacteria only when they are growing or dividing, and in this sense, the term 'fissibactericide' is tentatively suggested. Since the experimental work to date has eliminated most of the other phases in the growth-cycle as ones during

which the organism is most susceptible to the action of penicillin, the stem 'fissi-' has been chosen.

Additional work is being carried out which will extend observations on the *modus operandi* of fissibactericidal substances.

S. W. LEE.

E. J. FOLEY.

E. R. CALEY.

Wallace Laboratories, Incorporated,  
New Brunswick, New Jersey.

Feb. 20.

<sup>1</sup> Lee, S. W., Foley, E. J., Epstein, J. A., *J. Bact.*, **43**, 393 (1944), see references therein.

<sup>2</sup> Bigger, J. W., *Lancet*, 497 (1944).

### An Undialysable Pressor Principle in Organ Extracts

IN an earlier<sup>1</sup> communication the occurrence of an adrenaline-like pressor substance in ether extracts of various animal organs has been reported. The primary extracts were made with two volumes of alcohol. After evaporation of the alcohol from the filtrate and removal of fats and lipoids with ether, the clear aqueous phase was subjected to dialysis for forty-eight hours in 'Cellophane' bags against running water. The content in the bags after dialysis showed a strong pressor action on the cat in chloralose anaesthesia. On concentration and treatment with six volumes of alcohol, the pressor activity was found partly in the precipitate and partly in the filtrate. After this treatment the whole of the pressor activity became dialysable.

The two fractions, the alcohol-soluble and the alcohol-insoluble one, showed different properties. The former behaved in many respects like the adrenaline-like substance described earlier<sup>1</sup>, whereas the latter was stable in alkali but destroyed by heating in an acid solution.

Purification work and analysis of the biological actions is in progress.

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April 16.

<sup>1</sup> *Nature*, **156**, 18 (1945).

### Losses of Nitrous Nitrogen from Soils on Desiccation

LOSSES of nitrite nitrogen from acid soils have been reported by a number of workers<sup>1</sup>. Recently, during the course of our studies on the losses of nitrogen from soils, we noticed that a part of the nitrous nitrogen disappeared when soils with a pH value higher than 7.0 were allowed to dry.

TABLE 1. EFFECT OF DESICCATION ON NITROUS NITROGEN OF THE SOIL.

Serial No.	Treatment of the soil	Mgm. nitrogen per 100 gm. soil		
		Am. 'N'	Nitrous 'N'	Nitric 'N'
1	Control	0.84	0.01	1.6
2	" "	0.84	0.01	1.6
3	With 5 mgm. nitrous 'N'	0.75	1.02	1.6
4	" "	0.75	0.96	1.6

This observation was followed up to discover whether the observed disappearance of nitrous nitrogen took place due to one or the other of the following causes: (1) oxidation of nitrite nitrogen to nitrate; (2) reduction of nitrous nitrogen to ammonia; (3) assimilation of nitrous nitrogen by micro-organisms; (4) decomposition of nitrous nitrogen.

The results of experiments in this connexion showed that the disappearance of nitrous nitrogen was neither due to its oxidation or reduction, nor to its assimilation by micro-organisms, but that it was caused by its decomposition with the evolution of nitrous fumes. A desiccating soil containing 10 mgm. nitrous nitrogen per 100 gm. soil was actually found to smell of nitrogen peroxide.

Further experiments revealed that such losses took place only on desiccation and were not due to thermal decomposition of sodium nitrite.

TABLE 2. LOSSES OF NITROUS NITROGEN FROM SOILS KEPT AT 84° C. IN STOPPERED BOTTLES AND OPEN DISHES.

Serial No.	Treatment	Mgm. 'N' per 100 gm. soil	
		Nitrous 'N' in soil	Loss
1	Stoppered bottle	9.1	0.9
2	" "	9.1	0.9
3	Open dishes "	0.9	9.1
4	" "	0.8	9.2

The nature of the soil was found to have a significant effect on such losses.

TABLE 3. LOSSES OF NITROUS NITROGEN ON DESICCATION FROM DIFFERENT SOILS.

Serial No.	Soil	Mgm. nitrous 'N' per 100 gm. soil		
		pH	Nitrous 'N' in soil	Loss
1	Sandy loam	8.7	2.4	7.6
2	" "	8.7	2.6	7.4
3	Clay loam	8.7	1.1	8.9
4	" "	8.7	1.2	8.8
5	Saline soil*	9.5	1.9	8.1
6	" "	9.5	1.9	8.1
7	Alkali soil†	10.1	7.7	2.3
8	" "	10.1	7.7	2.3

\* Containing 1.02 per cent water-soluble salts (mostly chlorides, sulphate and carbonate of soda).

† Exchange complex nearly saturated with sodium ion.

Having established that nitrous nitrogen is actually lost from non-acid soils, experiments were conducted to study the reactions responsible for such losses. It was found that carbon dioxide and ammonia of the air, exchangeable hydrogen (which may be present in soils with pH higher than 7.0) and catalytic action of the soil were responsible for bringing about these losses. Of these the catalytic action of the soil seemed to be more important than others.

Detailed results are being published elsewhere.

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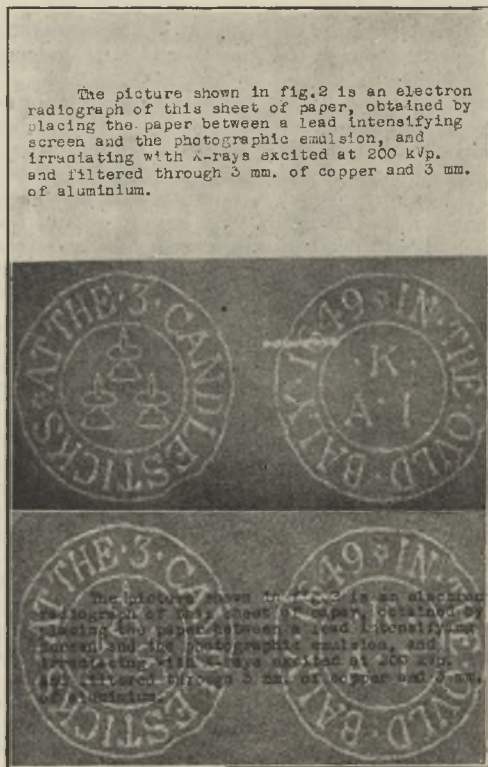
Bacteriological Research Laboratories,  
Punjab Agricultural College  
and Research Institute,  
Lyallpur.  
April 10.

<sup>1</sup> Fraps, G. S., and Sterges, A. J., *Soil Sci.*, 48, 175 (1939). Temple, J. C., *Bull. Ga. Agr. Expt. Stat.*, 103 (1914). von Turtschin, Th. W., *Bodenk. u. Pflanzenernähr.* (1939).

## 'Electron Radiography' using Secondary $\beta$ -Radiation from Lead Intensifying Screens

In order to obtain radiographs of thin, easily penetrated materials, X-rays generated at only a few thousand volts (that is, Grenz-rays) have been used. This necessitates the use of a special Grenz-ray tube having a window transparent to the rays. In numerous cases, however, excellent radiographs of such materials can be obtained with the apparatus more commonly available in a radiographic department, by employing the secondary  $\beta$ -radiation emitted under high-voltage X-ray excitation from the lead intensifying screens which are frequently used in high-voltage radiography.

The best procedure is to place the object to be examined between a lead screen and a photographic emulsion in an X-ray cassette, as used in medical or industrial radiography. The lead screen may be placed either between the emulsion and the X-ray tube or behind the emulsion; but in either case the second lead screen normally used in radiography should be dispensed with, and the object under examination should be in intimate contact with the photographic emulsion on one side and the lead screen on the other. Single-coated film is preferable to double-coated as the electrons from the lead are almost completely absorbed by the film base and consequently only affect one emulsion. The second emulsion, therefore, only serves to increase the fog on the film due to the direct action of the X-rays. A 'contrasty' type of emulsion has been found to



Top: PHOTOGRAPH OF SHEET OF PAPER USING REFLECTED LIGHT SHOWING SURFACE PRINTING.

Middle: 'ELECTRON RADIOGRAPH' OF PAPER SHOWING WATER-MARK AND ERASURE WITHOUT INTERFERENCE FROM PRINTING.

Bottom: TRANSMISSION PHOTOGRAPH WITH LIGHT; WATER-MARK AND ERASURE PARTLY OBLITERATED BY PRINTING.

give the best results, and process films are particularly suitable. In order to reduce the relative effect of the direct action of the X-rays, it has been found desirable to use as penetrating a primary beam as possible, and hence to use a high kilovoltage across the X-ray tube. 150 kVp. can be employed, but better results are obtained at 200 kVp. and in both cases the softer components of the radiation should be filtered out. It is possible, however, that with very high voltages the improvement in contrast due to reduction in the general X-ray fog may be offset by a reduction in contrast through the increasing energy and decreasing absorption of the secondary  $\beta$ -radiation from the lead.

Suitable materials for radiography by this technique include paper, plastic materials such as cellulose fabrics, nylon, etc., and certain botanical subjects such as tree and plant leaves. The method is particularly sensitive to differences in thickness, and records of paper structure, watermarks, and in some cases erasures, may be obtained from printed paper without interference from the printing since many printing inks give no radiographic image. The technique is illustrated by the accompanying 'electron radiograph' of a piece of paper and comparison photographs using reflected and transmitted light.

In some cases the results may be complicated by the emission of  $\beta$ -rays from the material it is desired to radiograph. This is particularly liable to occur if the material contains elements of high atomic number. In some cases a 'positive' may be obtained instead of a 'negative', due to the  $\beta$ -emission from the material itself more than compensating for its absorption of electrons from the lead screen. In addition, baryta-coated papers may give a poor result on account of a faint but perceptible fluorescence excited in some samples of baryta by X-rays; this tends to fog the emulsion and greatly reduces the contrast of the electron radiograph.

Although the effect has only been studied with lead screens, there is no reason why other metals of high atomic number, such as silver, platinum or gold, should not give a similar result.

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### Accuracy of Atomic Co-ordinates Derived from Fourier Synthesis

In a paper, to appear in full elsewhere, I have investigated the accuracy of the atomic co-ordinates obtained from the three-dimensional Fourier syntheses of X-ray crystal structure analysis.

Representing the synthesis in the form:

$$D(x,y,z) = \frac{1}{V} \sum_{HKL} |F(h,k,l)| \cos \left[ 2\pi \left( h \frac{x}{a} + k \frac{y}{b} + l \frac{z}{c} \right) - \alpha(h,k,l) \right], \quad (1)$$

and neglecting errors of computation, two sources of inaccuracy occur: (a) experimental errors in the  $|F|$  values; (b) errors due to  $(H,K,L)$  being finite.

Information as to the magnitude of the errors in the  $|F|$  values has recently become available during a redetermination of the structure of dibenzyl by Jeffrey<sup>1</sup>. This structure was originally examined by

Robertson<sup>2</sup>, and a comparison of the two sets of experimentally determined  $|F|$  values shows that the errors appear to be independent of the magnitude of the structure factors and to have a most probable value:

$$\Delta e = \pm 0.6. \quad (2)$$

Examination of the shape of the atomic peaks derived from a number of Fourier syntheses shows that the radial density distribution can be closely represented by the function:

$$d(r) = Ae^{-pr^2} \quad (3)$$

where  $A$  depends on the atomic number of the particular atom and  $p$  appears to be fairly constant over a number of atoms from carbon to sulphur, a mean value being,

$$p = 4.69. \quad (4)$$

A combined analytical-statistical analysis leads to the relation:

$$\epsilon < 90.8 \Delta e / N \sqrt{V(\lambda p)^{5/2}}, \quad (5)$$

where  $\epsilon$  is the most probable error in the co-ordinate,  $N$  is the atomic number of the particular atom,  $V$  is the volume of the unit cell in A.<sup>3</sup>, and  $\lambda$  is the wave-length corresponding to the smallest spacings observed. Taking the values of  $\Delta e$  and  $p$  given in (2) and (4), and considering a carbon atom in a unit cell of volume

$$V = 583 \text{ A.}^3, \quad (6)$$

equation (5) leads, when all the information obtainable with copper  $K\alpha$  radiation is used, to the value,

$$\epsilon < 0.0027 \text{ A.}$$

A formula is also given for the case in which errors are proportional to the order of their parent reflexions.

The problem of finite limits of summation is more complicated. For a simple system containing only two carbon atoms, the errors, calculated as upper limits, where  $\rho$  is the radius of the sphere containing the reciprocal points of all planes included in the summation, are:

$\rho$	$\epsilon(\text{A.})$
1.5	0.019
1.8	0.009
2.0	0.005

The polyatomic case cannot be given general expression since the atomic positions form a determined system and are not subject to statistical laws. In any given structure the errors can, however, be ascertained by the following procedure. Having calculated the structure factors from the final atomic co-ordinates, a synthesis is computed using these calculated values as coefficients. Any terms not included in the original synthesis with experimental coefficients are similarly omitted in this new synthesis. The co-ordinates derived will, in general, deviate slightly from those used in calculating the  $|F|$  values; these deviations give the errors, with reversed signs, of the original co-ordinates. A trial on an actual structure<sup>3</sup> shows them to have a value of about

$$\epsilon = \pm 0.02 \text{ A.} \quad (7)$$

It is suggested that by applying these corrections to derived co-ordinates more accurate values of the latter may be obtained, having errors approximately those of experiment given by equation (5).

Finally, the value of  $p$  is related to the quantity  $B$  defined by Debye<sup>4</sup> and Waller<sup>5</sup> by means of the equation

$$\frac{1}{p} = a(B + c), \dots (8)$$

where  $a$  and  $c$  are constants. This relation enables the effect of thermal agitation to be examined.

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<sup>1</sup> Jeffrey, private communication.

<sup>2</sup> Robertson, *Proc. Roy. Soc., A*, 150, 348 (1935).

<sup>3</sup> Jeffrey, *Proc. Roy. Soc., A*, 183, 388 (1945).

<sup>4</sup> Debye, *Ann. Phys.*, 43, 49 (1914).

<sup>5</sup> Waller, *Z. Phys.*, 83, 153 (1927).

## A Colour Reaction in Yeast

AFTER being dried at 90° C., bakers' yeast pre-treated with sodium fluoride assumes a more or less strong red colour, all according to the pH of the solution in which the yeast has been shaken. On the other hand, untreated yeast assumes a yellow colour after drying. With concentrated hydrochloric acid there is obtained from the red yeast a wine-red extract, which has a pronounced maximum at 4900 Å. Fig. 1 shows the absorption spectrum of the extract in half concentrated hydrochloric acid.

After drying at 90° untreated yeast also gives a red extract with hydrochloric acid with the same absorption spectrum as is shown in Fig. 1. The intensity of the colour is, however, weaker.

Quantitative photometric determinations were carried out with solutions obtained by the drying and extraction of untreated yeast and also yeast pre-treated with sodium fluoride at different pH's. The colour of the dried yeast was found to run parallel with the intensity of the colour of the extract. The maximal colour intensity was reached after a pre-treatment of the yeast with sodium fluoride at pH 4.

Yeast dried over phosphorus pentoxide at room temperature gives a violet extract with hydrochloric acid. In this case, too, the same difference between untreated yeast and yeast treated with sodium fluoride was noticed. But the colour of the dried, treated yeast differs very little from the yellow colour of the untreated yeast. To get a red yeast, as to get a red extract, it is necessary to heat to 90°.

Further, fresh yeast gives a violet-coloured extract with hydrochloric acid without drying. In this case, too, treatment of the yeast with sodium fluoride increases the intensity of colour.

Quantitative photometric determinations were made with solutions which were obtained after the

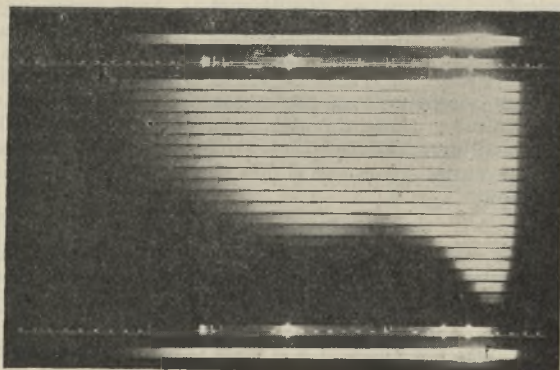


Fig. 1.

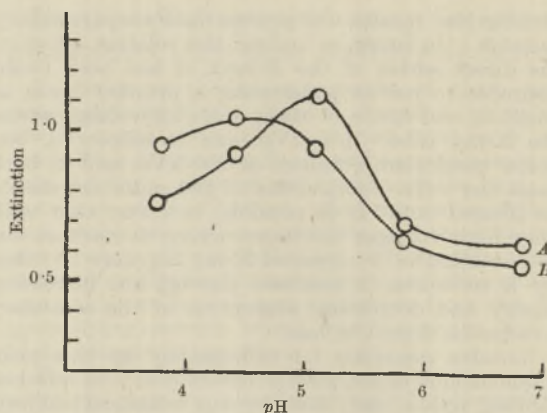


Fig. 2. CURVE A, VIOLET SOLUTION. CURVE B, RED SOLUTION.

extraction of, on one hand, fresh untreated yeast, and, on the other, with yeast treated with sodium fluoride at different pH's. Maximal colour intensity was reached after treatment at pH 5. Fig. 2 shows the dependence on pH of the colour intensity of the violet and red solutions respectively, the former measured with filter S 52, the latter with S 50, of the Pulfrich Stufenphotometer.

When concentrated hydrochloric acid is added to bakers' yeast dried at room temperature, a violet extract with the same absorption maximum as the violet solution from fresh yeast is also obtained. After the dried yeast has been shaken in water for several hours, the colour intensity of the extract is reduced by subsequent treatment with hydrochloric acid. The cause may be either a washing-out of the colour-giving substance from the cell, or its partial transformation to a non-colour-producing substance. To discover the cause the washing-water will be examined.

Attempts to identify the red and violet colouring-matters formed were chiefly made spectrophotometrically, since attempts to isolate them have not hitherto been successful. With great probability they are condensation products between compounds containing an indole nucleus (tryptophane, skatole, indole) and aldehyde or ketone derivatives in the presence of a strong acid. The absorption spectra of such dye-stuffs have been examined by Bardachzi<sup>1</sup>. He observed that the spectrum could be broken up partly by heat-treatment, partly by the choice of indole nucleus source (pure tryptophane or proteins), and he assumed this to be due to the manner of binding of the tryptophane in proteins and their higher breakdown products. There is good agreement between his curves and mine. That the spectrum is broken 200 Å. to the short-wave side in the case of the red extract in comparison with the violet one can thus be explained by Bardachzi's assumption.

In this reaction between tryptophane or its derivatives and carbohydrates in hydrochloric acid solution Jordan and Pryde<sup>2</sup> found a sensitive method of separating fructose from aldohexoses. Ketohexoses react at 40° in the course of 15 minutes, aldohexoses only at 80° in the same time. That fructose reacts specially sensitively is also known from other reactions, as in the Pettenkofer's reaction<sup>3</sup>, and in the reaction between carbohydrates and phenols<sup>4</sup>. As I found, at 40°, the hydrochloric acid extract from yeast pretreated with sodium fluoride reaches full colour intensity in five minutes, that from untreated yeast, on the other hand, only reaches a weak colour



at 40° in 15 minutes, and a full colour intensity only at 80° in the same time. Probably the promoting effect of sodium fluoride on the colour intensity is due to accumulation of ketose in the yeast. According to the findings of Jordan and Pryde, it is more likely a question of a hexosemonophosphoric or hexosediphosphoric acid accumulation than that of a triose.

In the case of yeast dried at room temperature, the drying process seems to play a similar part to the addition of sodium fluoride.

Experiments seem to show that in the case of ketoses the condensation with tryptophane commences at 90°, without the presence of a strong acid. Therefore in the case of red dried yeast, too, the assumption of ketose accumulation is a very probable explanation.

That the carbohydrate metabolism is disturbed by sodium fluoride is well known. In the presence of added substrate there is an accumulation of phosphoglyceric acid<sup>5,6,7</sup>. Without added substrate—as in my experiments—there is an accumulation of hexose monophosphoric acid in dried brewer's yeast<sup>5</sup>, hexose diphosphoric acid in dried plasmolysed baker's yeast<sup>8</sup>. There seem to be no reports of possible accumulation products in the absence of added substrate in fresh bakers' yeast, for which reason the above-mentioned observations might afford an insight into related problems. On the basis of the observations of Jordan and Pryde, a sensitive colour-reaction for ketoses could be developed with the yeast substances as reagents. The quantitative determinations which have been made indicate that such a method would render it possible to follow, in a simple manner, even small variations in the quantity of ketoses in the yeast under varying conditions.

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April 4.

- <sup>1</sup> Bardachzi, F., *Hoppe-Seylers Z.*, **48**, 145 (1906).  
<sup>2</sup> Jordan, C., and Pryde, J., *Biochem. J.*, **32**, 279 (1938).  
<sup>3</sup> Ohyama, Y., *J. Biochem.*, **27**, 351 (1938).  
<sup>4</sup> Karaoglanov, Z., *Z. analyt. Chem.*, **121**, 92 (1941).  
<sup>5</sup> Nilsson, R., *Sv. Vet. Ak. Ark. Kemi, Mineral. och Geol.*, **A**, **10**, No. 7 (1930).  
<sup>6</sup> Neuberg, C., and Kobel, M., *Biochem. Z.*, **263**, 221; **264**, 456 (1933).  
<sup>7</sup> Meyerhof, O., and Kiessling, W., *Biochem. Z.*, **267**, 351 (1933).  
<sup>8</sup> Myrback, K., and Ortenblad, B., *Biochem. Z.*, **292**, 230 (1937).

## Halogenation in the Allyl Position

WE should like to make a few comments on the recent communication by W. A. Waters<sup>1</sup> in criticism of F. S. Spring<sup>2</sup> for stating that substitution in the allyl position of olefines is a new reaction attributable to Ziegler and his collaborators<sup>3</sup>.

Although the reactions of halogen-containing substances with olefines to effect halo-substitution on allyl carbon atoms are of great interest, it seems to us that the most important reaction of allylic substitution is the *direct* halogenation of olefines at elevated temperatures discovered by Groll and others<sup>4</sup> in these Laboratories. Thus, for example, at temperatures of the order of 400° C., by an apparently homogeneous reaction, almost all the halogen in a 1 : 7 mixture of chlorine and propylene reacts readily by substitution to form allyl chloride. Bromine behaves similarly.

Waters conveys the impression that Farmer and

his colleagues<sup>5</sup> were the first to show that the substitution into olefines in the  $\alpha$ -methylene position was a reaction involving free radicals. In the reference to Farmer, cited by Waters, that author himself attributes the interpretation of the mechanisms of high temperature substitutive halogenation of olefines to two of the authors of this letter. It has been shown<sup>6</sup> that both addition and substitution occur under the experimental conditions principally, although not exclusively, by radical chain mechanisms, and that substitution is the dominant reaction at higher temperatures. Catalysis of the chain processes was achieved by the use of small amounts of tetra-ethyl lead, and, while under some conditions oxygen was a powerful suppressant of both reactions, under others a trace of oxygen acted as a powerful catalyst for the substitutive chlorination of propylene to form allyl chloride at temperatures as low as 272° C. In this connexion it may be mentioned that Ingold<sup>7</sup> states that peroxide catalysis (and hence by analogy oxygen catalysis) of a reaction is "compelling" evidence for a free radical mechanism. Such evidence is also accepted by Waters<sup>8</sup> as "conclusively" proving that such a process occurs. Of course, there is a wealth of experimental evidence for both acceleration and inhibition of radical reactions, from which may be cited Kharasch's oxygen- and peroxide-catalysed 'abnormal' addition of hydrogen bromide to unsymmetric olefines<sup>9</sup> and the quantitative photochemical 'anti-Markownikov' reaction involving such olefines and either hydrogen bromide or hydrogen sulphide<sup>10</sup>.

As have others in the past<sup>11</sup>, we wish to emphasize that the postulation<sup>12</sup> of free hydrogen atoms, produced by attack of organic radicals on molecules, as chain-carrying species in reactions is precarious, as the energetics of such reactions are generally entirely unfavourable.

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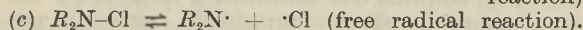
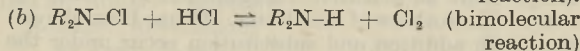
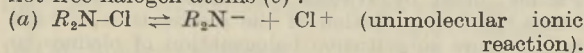
March 3.

- <sup>1</sup> *Nature*, **154**, 772 (1944).  
<sup>2</sup> Annual Reports of the Chemical Society, **40**, 101 (1943).  
<sup>3</sup> *Annalen der Chemie*, **551**, 80 (1942).  
<sup>4</sup> Groll and Hearne, *Ind. Eng. Chem.*, **31**, 1530 (1939). Engs and Redmond, U.S. Patent 2,077,382, April 20, 1937. Groll, Hearne, Burgin and LaFrance, U.S. Patent 2,130,084, September 13, 1938.  
<sup>5</sup> *Trans. Faraday Soc.*, **38**, 340 (1942).  
<sup>6</sup> *J. Org. Chem.*, **5**, 472 (1940).  
<sup>7</sup> *Trans. Faraday Soc.*, **37**, 791 (1941).  
<sup>8</sup> *Trans. Faraday Soc.*, **37**, 792 (1941).  
<sup>9</sup> See Mayo and Walling, *Chem. Rev.*, **27**, 351 (1940).  
<sup>10</sup> Vaughan and Rust, *J. Org. Chem.*, **7**, 472, 477 (1942).  
<sup>11</sup> See, for example, ref. (9), (p. 358); also, Weiss, *Trans. Faraday Soc.*, **37**, 793 (1941).  
<sup>12</sup> For example, see references (5) and (8).

As Spring noted in his report, due credit must be given to the chemists of the Shell Development Company of California for their original success in effecting the vapour-phase halogenation of olefines in the allyl position. While their evidence for the atomic mechanism of this process might have received mention, there can now be few chemists who would picture a homogeneous gas reaction of this type as anything other than a free radical process.

The mechanism of chlorine substitution in solution is, however, less well established, and in the

past the N-halogeno imides, such as Ziegler's reagents, have often been represented as yielding either halogen cations (a), or molecular halogens (b) and not free halogen atoms (c):



The prime reason for my comment in *Nature* of December 16, 1944, was to direct attention to this evidence for reaction by mechanism (c), in view of its theoretical significance in relation to the possible modes of covalent bond fission in solution, rather than to claim priority for proposing a mechanism for chlorination of olefines in the allyl position.

In establishing criteria for recognizing free radical reactions in solution, analogies with gas reactions are particularly valuable, though in commenting briefly on a particular reaction it is impossible to do more than cite recent relevant reviews (for example, my references 5 and 8).

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## Operators in Quantum Theory

IN his article on "Causality or Indeterminism?" in *Nature* of March 10, Prof. H. T. H. Piaggio refers to the restriction on quantum mechanical operators made by the condition that they be hypermaximal, and suggests that this conceals important requirements. In fact, the literature on the subject does not discuss the physical meaning of this requirement. Dirac, in his "Principles of Quantum Mechanics", substitutes the condition that "only those Hermitian operators that satisfy the expansion theorem represent observables": this is mathematically equivalent to hypermaximality, but also has no clear physical meaning.

The condition that an operator be Hermitian has the simple basis that the corresponding observable must have real values. It seems worth while to inquire what physical requirement on the operators can replace the above conditions. Now it can be shown that those, and only those, Hermitian operators are hypermaximal for which the corresponding Schrödinger equation

$$H \psi(t) = \frac{1}{i} \frac{d\psi}{dt}, \quad \dots \quad (1)$$

with the initial condition  $\psi(0) = \varphi$  has a solution for all positive and negative  $t$  and for every wave-function  $\varphi$  lying in the domain of the operator,  $H$ .

If, for example, we take the momentum operator for a line infinite in both directions—the operator

$\frac{1}{i} \frac{d}{dx}$  operating on wave functions  $\varphi(x)$  with

$$\int_{-\infty}^{\infty} |\varphi(x)|^2 dx = 1,$$

then the equation (1) with the initial condition  $\psi(x,0) = \varphi(x)$ , has the solution  $\psi(x,t) = \varphi(x+t)$  for all values of  $t$ .

If, on the other hand, we consider a half-infinite line, from 0 to  $\infty$ , the wave-function is  $\varphi(x)$  with  $0 \leq x < \infty$ . As is easily seen, the operator  $\frac{1}{i} \frac{d}{dx}$

operating on wave-functions in this half-infinite line is Hermitian if, and only if, its domain is confined to wave-functions with  $\varphi(0) = 0$ . The equation (1), with initial conditions  $\psi(x,0) = \varphi(x)$ , has the solution  $\psi(x,t) = \varphi(x+t)$  for all negative  $t$ , where we take  $\varphi(x) = 0$  if  $x < 0$ ; but for  $t > 0$  the solution is formally  $\varphi(x+t)$ , which does not lie in the domain of the operator if  $\varphi(t)$  is not zero. Hence the equation does not have a solution for all positive  $t$ . This corresponds to the obvious fact that a particle cannot move in a half-infinite strip with constant momentum for an infinitely long past and future.

The examples illustrate what happens in the general case; since the equation (1) is the equation of a system for which the probability that the observable corresponding to the operator  $H$  should have a given value, or should have a value lying in a given interval, is constant, we can restate the condition in the following form:

A Hermitian operator is hypermaximal if, and only if, it is possible for a physical system to maintain a constant probability distribution of the observable corresponding to the operator for a time infinite in both directions.

This condition makes it fairly obvious why only hypermaximal operators obey the expansion theorem. For that theorem to hold, the system must be capable of stationary states, that is, of states in which the probability distribution of the values of the observable is constant from  $t = -\infty$  to  $t = \infty$ .

This approach to operator theory seems to link it more closely with the physical theory than does the theory of von Neumann and Stone. In a paper to appear in the *Quarterly Journal of Mathematics*, I have shown that it leads to a proof of the spectral theorem rather simpler than those of von Neumann and Stone, and also have proved the equivalence of the condition stated with hypermaximality.

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University of London.  
April 10.

## Reform of the Patent Law in Britain

THE article on "Reform of the Patent Law in Britain"<sup>1</sup> criticizes my proposals for patent reform on the grounds that they would reduce the profitability of inventions to financial backers. I would maintain that my proposals would in general have no such effect. I have recommended that the Government should pay patentees rewards in proportion to the economic advantage arising from the application of their patents. Hence the wider these applications (be it by competitors of the patentees or by others) the higher the gains accruing to patentees. It is in fact an essential point of the proposed reform that it would not on the whole take away any of the financial stimulus for the exploitation of patents while leaving everyone free to use them. Even though a closer analysis might reveal cases in which the present form of patents would be somewhat more lucrative to patentees, these cases could be balanced by others in which the reverse would hold.

MICHAEL POLANYI.

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<sup>1</sup> *Nature*, 155, 612 (1945).

THE point raised by Prof. Polanyi appears to be based on a difference of opinion between him and the financial backers of inventors. He is of opinion that the proposed reform "would not on the whole take away any of the financial stimulus for the exploitation of patents while leaving everyone free to use them". On the other hand, however, the opinion of the financial backers, insofar as it has been indicated during recent discussions of suggestions for the compulsory licensing of all patents, is that the monopoly or *exclusive* licence obtained through the grant of a patent is generally necessary before the financial arrangements for commercial exploitation of an invention become practicable. The small number of patents that are voluntarily endorsed 'licences of right' under the existing arrangements shows that the opinion of inventors is, as a rule, in agreement with that of their financial backers.

THE WRITER OF THE ARTICLE.

### Strength of Glass and Duration of Stressing

IN the columns of *Nature* recently and in other places there have appeared various discussions of the relation between the strength of glass and the duration of the stressing, frequently centring on the experimental results of Mr. T. C. Baker reported in my paper on the "Mechanical Properties of Glass"<sup>1</sup> in the form of a graph. There, breaking stress is plotted as ordinate against the logarithm of the time as abscissa. This is the way the scanty earlier results were plotted by other investigators.

To save the time of those who have been trying to fit equations to this curve, I may point out that if *reciprocal* of stress is plotted against logarithm of time a perfect straight line is obtained, for the glass specimen, the equation of which is

$$f \times \log_{10}(t/6) = 65,000,$$

where  $f$  is breaking stress in lb./in.<sup>2</sup> and  $t$  is duration of steady load in microseconds.

If this curve can be extrapolated substantially the implications would be (a) at the long time end, the stress that can be supported for an infinitely long time is zero; (b) at the short time end, no finite stress can break these specimens if the duration is less than 6 microseconds.

The curve for porcelain rods shown in the same paper also reduces to a perfect straight line so far as the first five experimental points are concerned. The sixth point falls off the line, but the point was obtained by different apparatus in difficult circumstances and may perhaps be distinctly in error.

The physical meaning of implication (b), that glass and porcelain rods can stand an infinite load for a finite (but very short) time, is not at present clear. Perhaps the curve cannot be extrapolated too far that way, or perhaps the finite velocity of sound, or of crack propagation, comes in.

The outbreak of the War in the midst of Mr. Baker's researches, and other handicaps, have prevented any full account to the scientific Press of his work: the brief report in 1942 in my own paper above cited has caused much speculation, and Mr. Baker and I hope it may be possible to remedy the omission in the foreseeable future.

F. W. PRESTON.

### Avoidance of Obstacles by Bats

I HAVE read with great interest Mr. Pike's article on bats<sup>1</sup> and Squadron Leader A. K. McIntyre's letter<sup>2</sup> commenting on it. As the latter correctly states, it was Galambos and Griffin who were largely instrumental in proving that bats employ a supersonic form of acoustic 'radiolocation' when flying at night. They were not, however, the originators of this hypothesis, as they themselves state in their papers. This hypothesis was advanced by me as the result of a number of experiments performed in a set of rooms in King's College, Cambridge, the windows of which looked out on to the Cam. During the summer months, bats flew into these rooms in large numbers in the late evening and would remain there until dawn, flying round and round at will. They were unwitting collaborators in my experiments and continued to visit me without fear until the end of the long vacation. As a result of these visits I wrote an article in which I advanced the hypothesis that bats detect and avoid obstacles by hearing reflexions of high-pitched vocal sounds emitted during flight.<sup>3</sup>

This hypothesis has been substantiated in the three interesting papers by Galambos and Griffin.

The main problems of the flight of the bat apparently being solved, there are a number of minor ones to which attention may usefully be directed. I hope to deal with these later.

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<sup>1</sup> *Nature*, 155, 122 (1945).

<sup>2</sup> *Nature*, 155, 672 (1945).

<sup>3</sup> *J. Physiol.*, 54, 54 (1920).

### Archæological Exploration in South Africa

ON page 676 of *Nature* of June 2, 1945, reference is made to the South African laws which control the investigation of archæological sites and the collection and exportation of vertebrate fossils.

Control of archæological sites will meet with wide approval because their number is necessarily limited, and the evidence they can give is largely destroyed by excavation. But vertebrate fossils are in an entirely different position. The very important fossil faunas of the Karroo occur irregularly distributed over an area of some 100,000 square miles, a very considerable proportion of which is free from vegetation. They are, of course, not restricted to the surface, so that new specimens are constantly exposed by denudation. The total number exposed at this moment is certainly enormous, and it is certain that no conceivable amount of collecting can exhaust the field or even keep up with the exposure of new specimens.

A comparable case is that of the White River Bad Lands of South Dakota, where an area of some 2,000 square miles has been exploited for some fifty years by from one to a dozen parties each year and still yields enough to satisfy each visitor.

In fact, while the archæological restrictions are imposed for the protection of the evidence, that on fossil vertebrates is for the protection of the South African palæontologists, who do not appear to wish their colleagues to examine the new materials.

D. M. S. WATSON.

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<sup>1</sup> *J. Appl. Phys.*, 13, 623 (1942).

## SCIENCE AND EDUCATION

THE Leeds Branch of the Association of Scientific Workers organized a highly successful and well-attended conference on "Science and Education" in the Philosophical Hall of the Leeds City Museum on the afternoon of June 9. Dr. W. T. Astbury was in the chair, and the opening address on "The Educational Policy of the Association of Scientific Workers" was given by Sir Robert Watson-Watt, immediate past president.

Sir Robert said that the only valid objective of a political system is a fuller life for each individual citizen, and that such intermediate objectives as a flourishing export market are merely means to that main objective. Since the export market is necessary to the fuller life, we want, in its interests as well as for other reasons, more technicians, more technology, more scientific workers and more science. But our greatest real need is for more culture, and he hoped that there will be no self-consciousness or shamefacedness in our campaign for culture as the greatest human necessity. It is perhaps fortunate, but only incidental, that more culture is essential to the attaining of more and better science and technology, and thus to a better export market.

To get better men of science their education must be changed, and it cannot be changed sufficiently without changing the education of every pupil and student in the country. In the education of the man of science we must include more principles and fewer facts, since the available facts are now tending to crowd the principles out of our courses. In the education of every student we must include more science and not less of the humanities. The disease which has ravaged our modern world is a disease of malnutrition. Diseases of malnutrition contain two major factors, defects of intake and defects of assimilation. The world's intake of scientific facts and technical products is not, as is sometimes foolishly suggested, excessive; but the intake has grossly outrun our assimilative activity, our appreciation of the inter-relation of the facts and our ability to apply the products beneficially. How can we improve assimilation? Sir Robert said he had been profoundly shocked to hear the Minister for Education in the late Government—a highly successful and progressive Minister for Education—tell a university audience that he "had not much use for mathematics and science" and that "the essential element in our education must continue to be the classics, because the classics tell us how people behave and how they will always behave". A very little store of the humanities of mathematics and science would have safeguarded Mr. Butler from this vicious extrapolation. Even if it had failed in that, it would have carried him to the natural conclusion of his thought process, which is that if people go on behaving as they have been doing, they will deprive themselves of any opportunity of behaving at all.

We must change our education: but where to begin, with the Minister or with the infant pupil? The former is an unpromising and laborious undertaking; the latter is a promising but slow-maturing one, which we must begin now. The quickest result will come from educating our educators, and that can only be done in the one place where true education can be given to true educators, the university.

Sir Robert then summarized briefly the salient points in the policy for education published by the Association of Scientific Workers: For the university,

full access for all who can show a reasonable prospect of benefit, a doubled intake overall, a trebled intake for science, a trebled staff overall, capital expenditure of thirty million pounds in the next ten years, annual expenditure rising to the order of fifteen millions within five years, a national academic council, planned facilities for special schools avoiding alike complete monopoly and over-dispersal of the special facilities. For the national institutes of technology, which must be strengthened and extended to comparability with the best American models, integration into the university structure without confusing the frontiers between the basic sciences and the higher technologies. For the technical colleges, an upward levelling of status and facilities, and regional association around the regional university as an intellectual and educational focus. For the young peoples' colleges, a very great measure of autonomy to the student body, of self-government by the student for the student. For the part-time student, in the sixteen to eighteen age-group, half of the forty-four hour week devoted to daytime—and largely whole day—education, principally the education of the social conscience. For the post-primary pupil, a leaving age of 15+ as a most urgent interim measure, of 16+ at the earliest practicable epoch, and standardization at 16+ to facilitate uniformity of entry levels in the higher institutions. For the primary pupil, absorption of the common bases of scientific method through the pupils' own activity under the guidance of teachers who have themselves learned those bases for themselves. At all stages an intimate co-partnership with industry by the direct participation of those engaged in industry as members of council, as lecturers and as researchers.

Mr. H. Benfield, president of the Leeds Teachers Association, spoke on "The Place of Science in Primary Schools". Emphasizing the importance of basing education on the pupil's own activity and experience, on the encouragement of curiosity, the spirit of inquiry and wonder, he urged that nature study is the best initial approach to science, with progress from the collection of wild flowers through the primary school garden (left as nearly natural as possible) to the study of animals. The aquarium is a valuable means of overcoming urban limitations on this range of subjects. The pupil should learn to observe accurately, to record systematically—in pictorial form at first—and should not be launched in the primary stage on the formal study of a branch of science or of any organized science in detail.

Mr. E. J. Rose, Science Masters' Association, spoke on "The Teaching of Science in Secondary Schools", dealing with the age-group 12-16, with an advanced 50 per cent in the 16-18 group in present circumstances. Quoting the threefold justification for the place of science in a course the main aim of which is to provide an environment for the fullest development of the individual personality, the utilitarian or vocational, the disciplinary and the cultural, he said that while we stand high in literary and artistic performance, the highest glory of Western civilization is in its science. It is this glory, the glory of inquiry, which has to be revealed in the pupil's mind. Interpreting the syllabus for general science prepared by the Science Masters' Association, he re-emphasized the need for making full and continuous use of the pupil's own inventive capacity, the importance of the sentiment which grows up around any subject in the pupil's mind, the importance of adequate

demonstration work, but not at the expense of practical work by the student himself. He showed the need for improved facilities, for laboratory assistants, for equipment of the kind now plentiful in Service training (episcopes, epidiascopes, projectors and so on), for laboratories larger and more numerous than those of the present paper plans. Finally, he called for direct contact between the science teacher and the worker on the frontiers of science, so that the teacher might absorb and re-transmit the spirit of science.

Mr. J. Maddison, chairman of the Leeds Scientific Film Society, discussed "Teaching by means of the Scientific Film". He too stressed the practical problems of the film in education, the need for ample supplies of projectors and of copies of films, on a scale never yet reached in Great Britain. State production and use in war-time of instructional and informational films has shown the solution of these problems, by giving direct experience on a large scale in the economical making and utilization of such films, always a somewhat expensive business. That there are only 2,000 projectors, many unsuitable and many unserviceable, in British schools now is in part due to the apathy of teachers; that suitable films are scarce is due to the fact that there is no money in making educational films; the pre-war distribution of such films, costing £2,000 to make and £6-£7 per copy, was largely an aid to the sale of projectors.

The film must be a normal tool of teaching technique, and not a 'stunt' irruption into the classroom. It can be used as an incidental illustration to the lesson, as the central feature of the lesson, with other illustrative material grouped around it, or as an invaluable aid in the difficult task of keeping revision alive. The wider purposes of broadening the pupil's outlook, and awakening him to the excitement and drama of scientific outlook is better served by the use of the film in the main school hall, outside the classroom. The inadequate use of the film in adult education is largely governed by the economic factors common to juvenile and adult classrooms, but the commercial film theatre has its place in conveying the spirit and drama of science through the feature film, of which some dealing with continental scientific workers have been very good, though one dealing with a great English man of science was not a success. We need more projectors, more films, more skilled use and more research on the relation of the film to the learning process.

Prof. S. Brodetsky, ex-president of the Association of University Teachers, spoke on "Science and the University". He pointed out the close identity of the policies enunciated by the Association of University Teachers and the Association of Scientific Workers in relation to science and the universities, and suggested that closer co-operation based on this identity of view would be productive. He does not, however, believe that science in the university can stop short of the application stage; "Almost every branch of human activity is a branch of applied mathematics, if you look at it in the right way"; science produces the performance which is based on that application, and education in science cannot therefore be limited to principles. He commented on the relative failure to use the universities fully in the war effort; he regards the present tendency for "the Government to have its own private scientists" as an undesirable one.

There is a growing conviction that the university

course is far too restricted and degrees far too specialized. A four-year course, apart from the specialized work, is desirable, and should be directed towards understanding of the safe and cultured life, the development of human thought, with application to the principles of government, economics, medical methods and so on. The thinker, the poet, the man of science, the politician, must not be separated and compartmented; they should learn together that there is no such thing as a branch of learning which is not exciting, fascinating and thrilling.

Dr. P. D. Ritchie, of the Association of Teachers in Technical Institutes, dealt with "Part-Time Technical Education". In the qualifications which the part-time student should bring to part-time education, he puts "a near mastery of written and spoken English" first, ability to transfer thought to symbolism second, ability to transfer to another language third, and knowledge of scientific method only fourth. He believes that we should aim at higher institutes equal to or better than the Massachusetts Institute of Technology and the Zurich Polytechnic, and that the great range of unrelated *ad hoc* courses offered at the technical college level should be brought to a closer relationship leading to a recognized label such as an external B.Tech. degree.

Prof. J. B. Speakman, head of the Textile Department of the University of Leeds, thinks that "The Education of the Technologist" must be carried out in an atmosphere of research, and thus essentially in the university and nowhere but in the university. Part-time education, he said, is a barbaric survival from the industrial revolution. The industries get their leaders largely from the elementary schools, and these leaders have never had contact with the research method which can transform crafts into applied sciences distinguished in their own right. Technological education must provide the men who would understand this process and would become the business men of the future.

Mr. C. V. Bellamy, member of the local executive of the Workers' Educational Association, spoke of the obstacles to success in the proper placing of "Science in Adult Education". The average worker fears science and is nervous of his own ability to tackle anything so complex; there is a shortage of competent tutors—"not every university lecturer or schoolmaster is successful with classes of people tired after a day's work"—and facilities are inadequate, equipment being frequently limited to that which can be borrowed and carried by the tutor himself.

Mr. C. B. Bradley, from a long experience in the administration of education, emphasized the importance of a realization—not always achieved—by members of local authorities that their responsibility to the pupil must take precedence over their responsibility to the ratepayer. "The scene of the struggle for educational progress has now shifted from Parliament to your own Local Authority." The school building of 1870-75, very frequently still in use, is deplorably unsuitable; in buildings and equipment alike it is impossible to exaggerate the bad conditions that prevail in hundreds of elementary schools still in being in all parts of Britain.

The Leeds Branch of the Association of Scientific Workers hopes that in a month or two it may hold a second conference, which will discuss the specific action that should be based on the very comprehensive and stimulating survey of the whole field which was achieved in this first conference.

ROBERT WATSON-WATT.

## ESTIMATION OF MULTIPLE CORRELATION BY MEANS OF STEREOGRAPHIC PROJECTION

By G. F. K. NAYLOR

IN practice, the industrial psychologist is frequently faced with the situation in which he has to choose, from a trial test battery of say ten or more tests, those which will prove most effective in the selection of personnel according to some given criterion. He must then seek for answers to the following questions: (a) What is the individual validity of each test as judged by the criterion? (b) What combination of tests will give the best basis for prediction according to the criterion? (c) What will be the predictive value of such a combination? (d) How few tests may be used to obtain a validity coefficient the value of which does not depart appreciably from the theoretically best figure? (e) In what simple proportions must the scores of the chosen tests be weighted to obtain a close approximation to the best value of the joint validity coefficient?

The answer to (a) is obtainable only by direct correlation procedure, while those to (b), (c), (d) and (e) are normally reached after algebraic and arithmetical computations based upon the results of (a) and the inter-correlations between tests.

The recognized procedure is that of partial regression and multiple correlation, as developed by Udny Yule and Karl Pearson. Pearson in particular directed attention to the fact that the formulae developed by him for dealing with statistical selection (of which, as has recently been shown, partial correlation is merely a special case) can readily be interpreted in terms of spherical trigonometry, and printed a graph for dealing with the simplest cases of all. To avoid and illustrate the somewhat elaborate algebraic manipulations which multiple correlation involves, several other observers have used or suggested a graphical procedure. Kelley has proposed a simple 'alignment chart'<sup>2</sup>; for analogous problems in factor analysis Garnett has proposed to take cosines of angular distances to measure correlations (the basis of Thurstone's 'graphical rotation'); Burt has used the same principle with spherical trigonometry, using a 'globular' projection to obtain a two-dimensional representation<sup>3</sup>.

All these methods, however, are admittedly somewhat cumbersome: Pearson's full procedure, for example, required the use of a spherical trigonometery; and none has come into general use for practical purposes. Accordingly it is suggested that the following procedure will be found of great practical use. The chief novelties are (i) the use of a stereographic projection, and (ii) the combination of a graphical procedure with certain approximate equivalences similar to those used by Kelley in building up his multiple correlations. The method has already been used in selecting psychological test batteries of the ordinary type, and found sufficiently reliable for most practical purposes.

As with most other graphical methods, the underlying assumption is that the related variables can be represented by axes in space inclined to one another at angles the cosines of which are the respective correlation coefficients. On this basis three such variables may be represented as the angular points of a spherical triangle  $ABC$  (the points where such directions emerge from the sphere the centre of which

is the point of radiation). The sides of the triangle,  $a$ ,  $b$ , and  $c$ , represent the primary correlations  $r_{BC}$ ,  $r_{CA}$  and  $r_{AB}$  respectively, while its angles  $A$ ,  $B$  and  $C$  represent the partial correlations  $r_{BC.A}$ ,  $r_{CA.B}$  and  $r_{AB.C}$ , using the usual notation. It can then be shown that the perpendiculars from the vertices to the opposite sides represent the multiple correlations  $R_{A(BC)}$ ,  $R_{C(AB)}$  and  $R_{B(CA)}$ ; and the points where these perpendiculars meet the opposite sides indicate the combination of each pair of variables which correlates best with the remaining one. The weighting of standard scores for each pair of variables to produce the best correlation with the remaining one is in inverse proportion to the cosines of the angles at the points represented by the tests themselves, that is,

$$\frac{\text{Weighting } A}{\text{Weighting } B} = \frac{\cos B}{\cos A}$$

With the aid of a stereographic net, it is possible to cope with the three-dimensional problem on two-dimensional paper. The stereographic net as used in mineralogy or cartography is simply one of many devices which enables all points on the surface of a sphere to be represented on one plane, so that the angular distances between them may be read off directly in terms of any appropriate angular function; in this case the appropriate function is the cosine rather than the angle itself, and a net graduated in cosines is used in place of one graduated in degrees.

The method suggested below for estimating multiple correlations for more than two tests and a criterion differs from the more accurate but lengthier algebraic one, in that combinations of tests are built up successively instead of simultaneously. However, if care be taken to begin with the pair of tests which correlate best with the criterion (and, so far as is practicable, least with one another) the degree of error introduced in the succeeding steps appears to be in practice quite small in the case of ordinary aptitude test batteries. Moreover, the observed graphical result is slightly less than the possible maximum, so the estimate is conservative and safe to use; for example, in an example quoted by Holzinger<sup>4</sup>, concerning relation of Beta tests to Stanford Binet as a criterion, the stereographic method indicates that a multiple correlation coefficient of 0.72 could be obtained by the use of Tests 4, 7 and 3, whereas the computed value for the whole battery is given as 0.731. Garrett<sup>5</sup> works an example to estimate multiple correlation between three variables in combination and a criterion. His numerical result for the best combination is 0.83. The stereographic method gives proportions of 3, 2 and 1 as the values for approximate weighting of the three independent variables, 0.80 for the multiple correlation obtained by using these weights, and 0.72 as the correlation obtained by using unweighted scores. These examples are given to indicate the usual magnitude of error that has been observed by the Aptitude Testing Section of the R.A.A.F., where the method has been used for preliminary trials, the exact figure being afterwards computed for that particular combination which these trials show to be the best.

A theoretical justification of the procedure proposed for determining the multiple correlation may be given in terms of spherical trigonometry as follows. The deduction is based on a proof suggested by Prof. C. Burt; but the practical justification for the procedure proposed rests chiefly on its evident effectiveness as judged by a long series of trials with actual data. Actually, the use of the net for graphical work

is quite mechanical, and requires no special skill, once the three-dimensional principle is appreciated. In practice, the graph is plotted on transparent paper superimposed on the stereographic net, and rotated about the 'origin' by means of a pin stuck through the centre of the net.

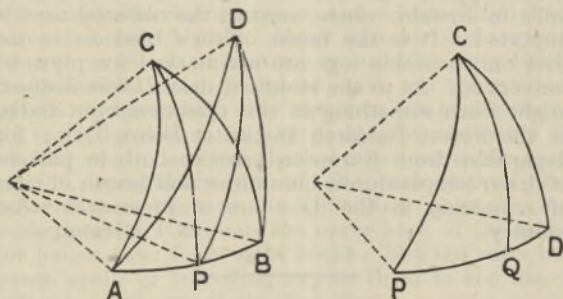


Fig. 1.

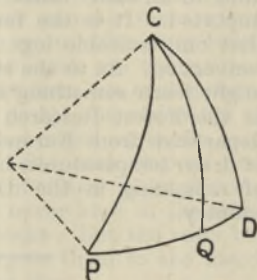


Fig. 2.

Consider a case of three tests  $A$ ,  $B$  and  $D$  and criterion  $C$ .

Step 1. In Fig. 1,  $ABC$  is a spherical triangle the sides of which are made to represent the inter-correlations of  $A$ ,  $B$  and  $C$ , that is, the cosines of the arcs are the correlation coefficients.  $CP$  is drawn at right angles to  $AB$ . Then  $CP$  may be shown to represent the multiple correlation  $R_{C(AB)}$ , thus:

In the triangle  $ACP$ ,

$$\sin \angle CAP = \frac{\sin \text{arc } CP \sin \angle CPA}{\sin \text{arc } AC}$$

But  $\sin \angle CPA = 1$ . Hence the equation may be rewritten

$$\sin \text{arc } CP = \sin \text{arc } AC \sin \angle CAP,$$

$$\sin^2 \text{arc } CP = \sin^2 \text{arc } AC \sin^2 \angle CAP,$$

$$1 - \cos^2 \text{arc } CP = (1 - \cos^2 \text{arc } AC)(1 - \cos^2 \angle CAP) \\ = (1 - r_{AC}^2)(1 - r_{CB.A}^2).$$

$$\text{But } R_{C(AB)} = \sqrt{\{1 - (1 - r_{AC}^2)(1 - r_{CB.A}^2)\}}$$

$$\text{Hence } \cos CP = R_{C(AB)}.$$

Step 2. In Fig. 1, on the same base  $AB$ , the triangle  $ABD$  is drawn representing the relationship between the three variables  $A$ ,  $B$  and  $D$ .  $D$  is joined to  $P$ , such that the arc  $DP$  now represents the relation between  $D$  and  $P$  (that is, the combination of  $A$  and  $B$  most closely related to  $C$ ).

Step 3. A new spherical triangle is now drawn (for the sake of clarity) in Fig. 2. In this triangle the base is  $PD$  (transferred from Fig. 1), and the other sides are  $PC$  (also transferred from Fig. 1) and  $DC$  representing the relation between  $D$  and  $C$ .  $CQ$  is now drawn perpendicular to  $PD$ , meeting it in  $Q$ .

Now, in the triangle  $CPQ$ , we have

$$\sin \angle CPQ = \frac{\sin \text{arc } CQ \sin \angle CQP}{\sin \text{arc } PC}$$

Since  $\angle CQP$  is a right angle, this may be rewritten:

$$\sin \text{arc } CQ = \sin \angle CPQ \sin \text{arc } PC.$$

But in Step 1 we have already shown that  $\sin \text{arc } PC = \sin \text{arc } AC \sin \angle CAP$ .

Therefore,  $\sin \text{arc } CQ = \sin \angle CPQ \sin \text{arc } AC \sin \angle CAP$ .

$$\text{Therefore, } 1 - \cos^2 \text{arc } CQ = (1 - \cos^2 \angle CPQ) \\ (1 - \cos^2 \text{arc } AC)(1 - \cos^2 \angle CAP).$$

Now  $\cos \angle CAP = r_{CB.A}$ , and similarly  $\cos \angle CPQ = r_{CD.P}$ ; or, in other words,  $r_{CD.AB}$ , since  $P$  may be taken as representing  $A$  and  $B$  simultaneously. (This is, of course, only an approximation.  $P$  represents the weighted sum of  $A$  and  $B$ , and eliminating a weighted combination is not quite the same as eliminating  $A$  and  $B$  by the usual formula.)

$\cos \text{arc } AC$  is, of course,  $r_{AC}$ .

Hence the equation becomes:

$$\cos \text{arc } CQ = \sqrt{\{1 - (1 - r_{CD.AB}^2)(1 - r_{AC}^2)(1 - r_{CB.A}^2)\}}.$$

This is in the form of the equation for multiple correlation; and yields a procedure for estimating  $R_{C(PD)}$  as an approximation to the true multiple correlation  $R_{C(ABD)}$ .

As pointed out earlier, the weights to be attributed to each test are represented inversely by the cosines of the base angles. (With the stereographic net, the cosine values may be obtained by the use of the 'meridians' as distinct from the 'parallels'. Another approximation is involved here at stages beyond the first combination, for then the partial regression coefficients are not quite equal to the partial correlations.) Thus, the relative weights for  $A$  and  $B$  used in the combination can be obtained exactly from the triangle  $ABC$  while the proportion of weighting of  $(AB)$  to  $D$  can be obtained from the base angles of the triangle  $PCD$  (Fig. 2). From this, the composite weighting for  $A$ ,  $B$  and  $D$  can easily be estimated. This also will not be quite exact as the relative weights of  $A$  and  $B$  will be the same in the final result as they were before test  $D$  was added to the combination. However, since  $A$  and  $B$  are the tests making the greatest contribution, it is clear that the total error involved will be small; and less than that which would occur if the tests were combined without regard to weighting at all.

A simple extension of this method in which instead of perpendiculars, lines (arcs of great circles) are drawn from the vertices to the mid-point of the base, enables a value to be estimated for the multiple correlation coefficient which would be obtained by combining the tests in equal proportions. This may, if necessary, be compared with that obtained by the more accurate method in order to establish the advantage in the particular circumstances of using the weighted as distinct from the unweighted test combination.

In the case of analysing the relationships between tests of a large battery, the process of projecting them as points with reference to a base-line consisting of any two of the variables is quite illuminating, especially if something definite is already known about the variables used as the base. By changing the base several times and replotting, the tendency of certain tests to form 'inseparable' pairs or groups may be qualitatively and quantitatively examined.

I gratefully acknowledge the assistance given by Prof. Cyril Burt in discussing the problems considered in this paper, but do not wish him to be held responsible for any inconsistencies in the final presentation.

<sup>1</sup> *Phil. Trans. Roy. Soc., A*, 200, 1 (1902).

<sup>2</sup> "Textbook of Statistical Method", 291-310 (1923).

<sup>3</sup> "Factors of the Mind", 81, 88 and refs. (1940).

<sup>4</sup> Holzinger, "Statistical Methods for Students in Education", 309.

<sup>5</sup> Garrett, "Statistics in Psychology and Education" (2nd edition), 488-39.

## INDIGENOUS FORESTS OF NEW ZEALAND

IT is rather illuminating to realize that some of our English characteristics are just as strong in a Dominion. The 'hands off the New Forest' controversy when the Forestry Commission suggested undertaking certain operations will be remembered. Beauty spots in that region or elsewhere in Great Britain may chiefly depend upon the presence of a clump or block of old trees—very beautiful things. The argument is that it would be desecration to touch them. Since the trees will not stand for ever, this means that our children or grandchildren will never see that particular beauty spot.

In the report for 1944 of the New Zealand State Forest Service (Gov. Printer, Wellington, 1944) the attitude has arisen on a larger scale. New Zealand has still left a considerable area of its old indigenous forests, although exotic conifers have been planted on a very extensive scale. Arising from the admirable soil conservation schemes now under consideration in the Dominion is one aspect which constitutes a serious threat to these national forests. It is the 'hands off' policy once again. "Well meaning but unrealistic enthusiasts," says the report, "advocate a lock-up-use-not policy of forest reservation, under the mistaken impression that such a practice will perpetuate the principal indigenous species—such as rimu, matai, etc. The exact reverse would occur in most forests. Why do so many of our rimu forests consist of virtually only old trees with seedlings and medium-age trees so few as to be insignificant? The initial cause is the fact that, no matter how prolifically the old trees seed, the humus on the floor is so thick that even when the seeds germinate, roots are seldom able to penetrate to the mineral soil beneath, and most seedlings therefore die." The Director of Forestry, continuing, points out that owing to the density of shade such seedlings as do develop gradually die from want of light, while in other parts of the forests inferior species capable of standing more shade are ousting the more valuable ones.

The Director deals with the whole matter clearly, giving a sylvicultural exposition with which a forestry student is well acquainted at the end of his first year's study—data so little known in spite of their elementary nature that ignorance thereof is imperilling the future of the Dominion's indigenous forests. Controlled logging and fire protection are advocated as the methods to be introduced. It is the logging, that is, felling any of the trees, which the opponents object to. The answer is a condemned and disappearing forest.

In connexion with this logging in indigenous forest, an almost inevitable discovery has been made, meriting consideration outside New Zealand. New plywood factories were to provide plywood for defence works and a junior technical officer of the Forest Service was stationed at one of these to assist in the solution of current problems in the manufacture of both casein- and resin-bonded plywood for defence works. Marked advances in manufacturing technique have been made, but there is said to be room for improvement. The tentative conclusion has been arrived at that the high moisture content of rimu and other indigenous logs makes it extremely difficult to dry their veneers in standard driers and at the rates, temperatures and humidities usually employed in plywood manufacture. On the subject

of peeler-logs, it has been established that the quality of the local product, if it is to compete successfully with imported plywoods on a quality basis, will have to be improved. Straightness of grain and reasonable freedom from defects are essential to the production of sheets free from twist and warp, etc.

This applies equally to the logs used in the plywood mills in Britain, where most of the material used is imported. It is the forest officer's business to see that only suitable logs are ear-marked for plywood conversion. As to the standard driers, New Zealand might learn something in this direction from India, at the Forest Research Institute, Dehra Dun; for departures from European practice both in pattern of drier, temperatures, humidities and length of time of remaining in the drier are in practice in that country.

E. P. STEBBING.

## BRITISH ARMY VETERINARY SERVICES IN THE FAR EAST

A PREVIOUS note (*Nature*, Jan. 13, 1945, p. 60) described the great responsibilities and high quality of the work of the Army Veterinary Services in the Near East. In the Far East, says Brigadier E. S. W. Peatt (*Vet. Record*, May 12, 1945, p. 219), even greater responsibilities are being undertaken. The campaign in Burma made necessary a return to animal transport, and this fact, together with the duty of providing fresh meat for the troops, made necessary an organization for the care of a great variety of animals. The result has been that the British and Indian veterinary personnel has increased to ten times its pre-war strength and further increases are likely.

Adequate training in veterinary tropical medicine was an early problem, and in October 1942 the Indian Army Veterinary Corps Training Centre was established. Its Officers' Training School now gives a training lasting two months to fifty officers at a time and its training wing gives to 1,200 men at a time a course lasting five months. Both courses are designed to produce competent soldiers as well as competent veterinary personnel, because the necessity of military as well as veterinary training has often been demonstrated in the fighting in Burma and Arakan. Farriers are trained in the Army Veterinary School; the classes consist of twenty-four students and extend over sixteen weeks, this training being continuous throughout the year. The same School gives continuous instruction in veterinary first-aid, animal management and the care of cattle, sheep and goats purchased for slaughter.

The care of transport animals used for military purposes involves the care of horses, mules and donkeys used in operational areas; the care of bullocks used on peace stations so that horses and mules can be released for operational work; the care of the camels, which are restricted by climatic conditions to the North-West Frontier and the Punjab; and the care of elephants used in the Burmese jungle. But, in addition to all this work, the Army Veterinary Service has the important responsibility of the control of the military dairy farms, and it has been necessary to set up a separate veterinary organization to deal with these. The Military Dairy Farms Department has increased its milch cattle from 10,000 to more than 60,000, and to-day it is probably the biggest



dairy organization in the world. Although there are 290 million cattle in India, the provision of fresh meat for the troops is made more than usually difficult by the climate, the enormous distances involved, the many infectious diseases and the fact that Indian animals are not bred and fattened for slaughter. Several hundred thousand animals are bought each year for slaughter, and the Army Veterinary Service examines and selects them and cares for their health. Many animals must spend from three to ten days in the train before they reach their destinations. Slaughter stock are transported by sea voyages which may last from one to five days, by train, by motor, on foot or by a combination of all four methods; and the hot weather, traffic congestion, compulsory use of all-metal wagons and other factors increase the difficulties of organizing such journeys. Animals are never kept in the train for longer than forty-eight hours; but the rests between spells of travelling expose them to the many infectious diseases of the Far East.

A further responsibility of the Army Veterinary Service is the breeding, through local development schemes, of pigs, rabbits and poultry, and these animals present their own disease problems. The Army Veterinary Service also inspects the meat and provides the Veterinary Wing of the Chemical Defence Research Establishment, which deals with the defence of animals against gas warfare. The Army Veterinary Laboratory Services and their mobile laboratories prepare vaccines and undertake routine and other diagnostic work. Nowhere else in the world, says Brigadier Peatt, does the veterinary officer encounter such a variety of diseases. A good example of the military importance of these diseases is the outbreak of the equine trypanosomiasis called 'surra' in 1942 on the Assam-Burma border. At one time 17 per cent of the horses and mules were put out of action by this disease, but the control measures adopted reduced the percentage of infected animals from 17 per cent in 1942 to 7 per cent in 1943 and 2 per cent in 1944. The Army Veterinary Service devised the method of injecting 'Antrypol' intravenously and obtained by this method 90 per cent of recoveries from this disease. Anti-surra units have now been formed.

Two other important diseases are anthrax and rinderpest, against both of which all cattle purchased and many sheep and goats are immunized. Rinderpest is the most important cattle disease in India. Although many thousands of cattle owned by civilians have died near the military dairy farms, the losses on these farms have been negligible (less than 1 per cent in 1943-44). Outbreaks of glanders have been quickly controlled, epizootic lymphangitis and strangles are being studied, precautions against foot-and-mouth disease, which is extremely widespread in India, are being taken, and the control of variola, which is usually introduced to dairy farms by buffaloes which have been bought, is being improved. Among the serious diseases of the smaller animals are pasteurellosis, salmonellosis and Ranikhet (Newcastle or Doyle's disease), and research upon the control of these is being done.

It is clear that the Army Veterinary Service is doing in the Far East a fine job which is vital to the success of the war against Japan. The quiet efficiency and progressive spirit of this work show how much the veterinary profession can contribute to the solution of the vast food problems of the post-war world.

G. LAPAGE.

## ARTS AND CRAFTS OF THE COOK ISLANDS

IN a large and profusely illustrated volume the Director of the Bishop Museum gives a comprehensive and detailed account of the material culture of the Cook Islands\*. The Polynesians are known for their clever workmanship and, as the illustrations show, these islanders are no exception, whether they are carving wood or plaiting fibres. The greater portion of the book is concerned with a description of the arts and crafts, including religious symbols, and this is followed by a discussion of their implications.

A study of the material culture of the Cook Islands shows that there are three cultural periods, a fact that may be best understood by the racial history of its inhabitants. The Polynesian ancestors, as it is now recognized, came from the mainland of Asia into Indonesia where they adjusted their continental culture to suit volcanic islands the fertile soil of which produced abundant food and where a rich culture developed. From Indonesia they passed on to Micronesia, the coral atolls of which formed a barren contrast; arts and crafts suffered drastic changes owing to the loss of food plants and raw material of wood and stone, and the people retrogressed from the stone age to a shell age. From here these ancestors, in the course of ages, moved westwards and finally arrived at the Society Islands, where they were once more on volcanic soil, so that stone was again available and the rich soil provided ample food. On these islands the Polynesians settled and from them they radiated out to the various island groups they were destined to colonize. They rediscovered the use of stone, and food plants and animals were probably introduced from the Melanesians in Fiji.

It was in this period of expansion that the Cook Islands were settled—roughly six hundred years ago—the culture being identical with that of the parent colony of the Society Islands, and this forms the first phase. Modifications and local developments have naturally taken place in both island groups so that it is difficult to give an exact picture of this early stage, but certain elements can be reconstructed. Some cultural processes, which may be regarded as stable, persisted unchanged until European occupation; examples of these are the plough method of firemaking and the earth-oven. The second period was one of developments rather than of any very sudden change. These may be due to diffusion owing to migration or importation or they may be caused by the substitution of another material or technique. Occasionally a new local technique is invented, such as the decorated borders to the pandanus sleeping mats that are peculiar to the Cook Islands.

The third period begins with the arrival of the white people. Early European voyagers bartered hoop iron and axes for fresh food, and the natives were quick to realize the superiority of metal over stone and to acquire it whenever possible. With the coming of the missionaries clothing was altered both in design and in material, and as time went on most of the old culture became obsolete. The new generation has grown up under these changed conditions and the cultural invasion is firmly established, for the natives will not give up the material comforts of to-day for any mental satisfaction connected with a sentimental past.

K. RISHBETH.

\* Arts and Crafts of the Cook Islands. By Te Rangī Hiroa (Peter H. Buck), Bernice P. Bishop Museum Bull. 179 (1944).

## FORTHCOMING EVENTS

Wednesday, July 18

INSTITUTION OF MINING ENGINEERS (at the Midland Counties Institution of Engineers, Nottingham)—Fifty-first Annual General Meeting. Mr. T. E. B. Young and Mr. W. H. Sansom: "Simultaneous Cutter and Loader for Longwall Mining".

ROYAL INSTITUTE OF CHEMISTRY (BIRMINGHAM AND MIDLANDS SECTION) (in the English Theatre, The University, Edmund Street, Birmingham), at 6.30 p.m.—Dr. Dorothy Jordan-Lloyd: "Protein Fibres".

Friday, July 20

BIOCHEMICAL SOCIETY (in the School of Medicine, Thoresby Place, Leeds 2), at 2.30 p.m.—Scientific Papers.

## APPOINTMENTS VACANT

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

TEACHER OF GENERAL ENGINEERING SUBJECTS (including ELECTRICAL), in the Bootle Municipal Technical College and Boys' Secondary School (Trinity)—The Director of Education, Education Offices, Town Hall, Bootle (July 20).

CIVIL ENGINEERS by Control Commission for Germany: (a) ASSISTANT CONTROLLERS (Ref. E.1677.A) with wide experience in Civil Engineering Design and Construction, including Water Supply, Sewage Disposal, Civil Engineering Plant and Building Construction; (b) CHIEF and SENIOR TECHNICAL ASSISTANTS (Ref. E.1680.A) with good experience in Civil Engineering work in some or all of the following—Water Supply, Sewage Disposal, Civil Engineering Plant, Building Construction, Demolition, and Recovery of Salvaged Material—The Ministry of Labour and National Service, Room 670, York House, Kingsway, London, W.C.2, quoting the appropriate Ref. No. (July 20).

LECTURER IN MATHEMATICS—The Principal, Derby Technical College, Normanton Road, Derby (July 20).

LECTURER IN MECHANICAL ENGINEERING with special knowledge of HYDRAULICS and/or AERONAUTICS, a LECTURER IN MECHANICAL ENGINEERING, and a LECTURER IN ENGINEERING DRAWING—The Clerk to the Governing Body, Battersea Polytechnic, Battersea, London, S.W.11 (July 21).

LECTURER IN PHYSIOLOGY AND ANATOMY, mainly to Sister Tutors—The Clerk to the Governors, South-West Essex Technical College and School of Art, Forest Road, Walthamstow, London, E.17 (July 21).

TEACHERS (2) for SCIENCE and MATHEMATICS at the East Ham Technical College—The Chief Education Officer, Education Office, Town Hall Annex, Barking Road, London, E.6 (July 21).

ASSISTANT (temporary) to the ADVISORY BACTERIOLOGIST—The Secretary, Edinburgh and East of Scotland College of Agriculture, 13 George Square, Edinburgh 8 (July 21).

ASSISTANT LECTURER IN PHYSICS, and a DEMONSTRATOR IN ZOOLOGY—The Registrar, University College, Nottingham (July 21).

TEACHERS OF ENGINEERING SUBJECTS with special qualifications in (a) HEAT ENGINES, (b) ELECTRICAL ENGINEERING, and (c) PRODUCTION ENGINEERING, in the Municipal College—The Chief Education Officer, 215 High Street, Smethwick (July 23).

LECTURER IN ECONOMICS—The Secretary, Queen's University, Belfast (July 24).

TRANSPORT and MECHANICAL ENGINEERING ASSISTANT (temporary)—The Town Clerk, Town Hall, Camberwell, London, S.E.5 (July 25).

CHAIR OF PHARMACOLOGY, tenable at the College of the Pharmaceutical Society—The Academic Registrar, University of London, Richmond College, Richmond, Surrey (July 26).

ASSISTANT MUNICIPAL ENGINEER by the Actra Town Council, Gold Coast—The Ministry of Labour and National Service, Appointments Department A.9, Room 670, York House, Kingsway, London, W.C.2, quoting E.1174.A (July 27).

ENGINEERS, PHYSICISTS and APPLIED MATHEMATICIANS at the Building Research Station, Garston, Watford, for research and other technical work on Building—The Ministry of Labour and National Service, Appointments Department A.9, Room 670, York House, Kingsway, London, W.C.2, quoting D.S.I.R. (July 28).

DEPUTY SECRETARY—The Secretary, Institute of Fuel, 30 Bramham Gardens, London, S.W.5 (endorsed 'Deputy Secretary') (July 30).

ASSISTANT IN BOTANY—The Secretary, The University, Aberdeen (July 30).

ASSISTANT ENGINEERS—The Clerk to the Metropolitan Water Board, New River Head, Rosebery Avenue, London, E.C.1 (endorsed 'Assistant Engineer') (July 31).

EDUCATIONAL PSYCHOLOGIST (part-time) at the Preston Child Guidance Clinic—The Director of Education, Municipal Building, Preston (August 9).

LECTURER IN MATHEMATICS in the University of Tasmania—The Agent-General for Tasmania, Australia House, Aldwych, London, W.C.2 (August 15).

ASSISTANT REGISTRAR—The Registrar, The University, Liverpool (August 15).

PRINCIPAL OF THE SIR JOHN CASS TECHNICAL INSTITUTE—The Correspondent, Sir John Cass's Foundation, 31 Jewry Street, London, E.C.3 (August 31).

PROFESSOR OF METALLURGY—The Registrar, King's College, Newcastle-upon-Tyne (August 31).

SECRETARY and LIBRARIAN—The Director, Institute of Historical Research (University of London), Tavistock House South, Tavistock Square, London, W.C.1 (August 31).

MEDICAL OFFICER to the University—The Secretary, The University, Edmund Street, Birmingham, 3 (September 3).

LECTURER IN DENTAL PATHOLOGY and BACTERIOLOGY—The Registrar, The University, Liverpool (September 30).

Grade III ASSISTANT LECTURERS (2) in APPLIED MATHEMATICS—The Registrar, The University, Liverpool (October 1).

NUFFIELD CHAIR OF CHILD HEALTH, tenable at the Institute of Child Health—The Academic Registrar, University of London, Richmond College, Richmond, Surrey (October 1).

CHAIR OF MORAL PHILOSOPHY—The Secretary of University Court, The University, Glasgow (October 15).

LECTURERS IN NATURAL HISTORY, NATURAL PHILOSOPHY, CHEMISTRY, MATHEMATICS, and STATISTICS—The Secretary, The University, Aberdeen (October 15).

TEACHER OF MATHEMATICS and ENGLISH with HISTORY or GEOGRAPHY as subsidiary, and Teachers (2) of ENGINEERING SUBJECTS (MATHEMATICS, SCIENCE and DRAWING) up to National Certificate standard—Miss P. E. Roberts, Art and Technical Institute, Yeovil, Somerset.

LECTURER IN PHYSICAL CHEMISTRY in the Victoria University College, Wellington, New Zealand—The Secretary, Universities Bureau of the British Empire, c/o University College, Gower Street, London, W.C.1.

CHIEF LABORATORY STEWARD in the CHEMISTRY DEPARTMENT—The Clerk to the Governors, Woolwich Polytechnic, Woolwich, London, S.E.18.

INDUSTRIAL INVESTIGATORS (graduates, men or women), and VOCATIONAL ADVISERS (graduates, men or women)—The Director, National Institute of Industrial Psychology, Aldwych House, Aldwych, London, W.C.2.

ADVISED IN PSYCHOLOGY to the Government of India in the Home Department—The Secretary, India and Burma Recruitment, India Office, Whitehall, London, S.W.1.

HEAD OF THE BIOLOGY DEPARTMENT—The Principal, Harper Adams Agricultural College, Newport, Shropshire.

ASSISTANT MASTERS (2) to teach MATHEMATICS in the Junior Technical School and to day-time released students up to Higher National Certificate standard, (b) to teach PHYSICS and CHEMISTRY in the Junior Technical School and CHEMISTRY to part-time students up to National Certificate standard, in the Corby Monotechnic Institute and Junior Technical School—The Chief Education Officer, County Education Offices, Northampton.

ASSISTANT CHEMIST at the Langford Treatment Plant and Laboratory, Maldon—The Engineer, Southend Waterworks Company, 13 Cambridge Road, Southend-on-Sea.

## REPORTS and other PUBLICATIONS

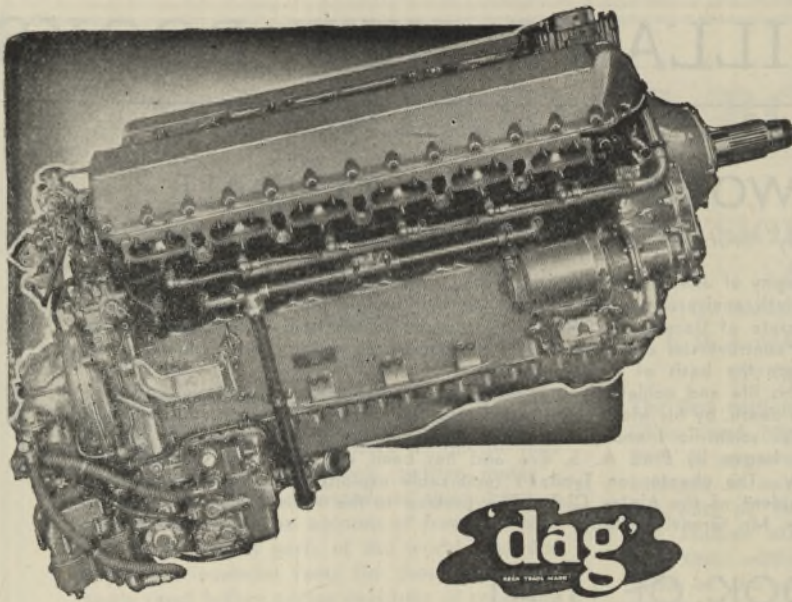
(not included in the monthly Books Supplement)

## Great Britain and Ireland

- Scientific Proceedings of the Royal Dublin Society. Vol. 24 (N.S.). No. 2: Observations on *Gibbirella saubinetti* (Mont.) Sacc. on Cereals in Ireland in 1943 and 1944. By Dr. Robert McKay and James B. Loughane. Pp. 10+1 plate. (Dublin: Hodges, Figgis and Co., Ltd.; London: Williams and Norgate, Ltd., 1945.) 1s. 6d. [26  
Gas Research Board. Fifth Annual Report 1943-1944. (Communication G.R.B. 11.) Pp. 54. (London: Gas Research Board, 1944.) [96  
Medical Research Council. War Memorandum No. 14: Nutritive Values of Wartime Foods. Tables compiled for the Accessory Food Factors Committee. Pp. 60. (London: H.M. Stationery Office, 1945.) 1s. net. [116  
British Ecological Society. Memorandum on Wild Life Conservation and Ecological Research from the National Standpoint. Pp. 15. (Cambridge: At the University Press, 1945.) 6d. [166  
Report of the Rugby School Natural History Society for the Year 1944. (Seventy-eighth Issue.) Pp. 58. (Rugby: George Over (Rugby), Ltd., 1945.) [206  
Proceedings of the Royal Irish Academy. Vol. 50, Section A, No. 9: On Distant Affine Connection. By Erwin Schrödinger. Pp. 143-154. 1s. Vol. 50, Section A, No. 10: On the Production of Mesons by Proton-Proton Collisions. 2. By W. Heitler. Pp. 155-166. 1s. Vol. 50, Section A, No. 11: The Point Singularity in a Non-Linear Meson Theory. By the Rev. Pius Walsh. Pp. 167-188. 2s. (Dublin: Hodges, Figgis and Co., Ltd.; London: Williams and Norgate, Ltd., 1945.) [206

## Other Countries

- Papers of the Michigan Academy of Science, Arts and Letters. Vol. 26 (1940), containing Papers submitted at the Annual Meeting in 1940. Edited by Eugene S. McCartney and Mischa Titiev. Pp. xiii+586+6 plates. (Ann Arbor, Mich.: University of Michigan Press; London: Oxford University Press, 1941.) 28s. net. [195  
Timber Control: Notes on Insect Damage to East African Timbers. By T. W. Kirkpatrick. Pp. 32. (Nairobi: East African War Supplies Board, Timber Control, 1944.) 2s. 6d. [265  
East African Agricultural Research Institute. An Annotated Bibliography of Cinchona-growing, from 1883 to 1943. By R. E. Moreau. Pp. 42. (Nairobi: Government Printer, 1945.) [265  
Coryndon Memorial Museum. Occasional Paper No. 1: A Contribution to the Study of the Tumbian Culture in East Africa. By L. S. B. Leakey and Archdeacon Owen. Pp. iv+55 (20 plates). (Nairobi: Coryndon Memorial Museum; Cambridge: Deighton, Bell and Co., Ltd., 1945.) 5s. [26  
Annual Report of Durban Museum and Art Gallery for the Year 1943-1944. Pp. 8+4 plates. (Durban: Museum and Art Gallery, 1945.) [26  
Commonwealth of Australia: Council for Scientific and Industrial Research. Bulletin No. 182: The Effectiveness of Various Mineral Dusts for the Control of Grain Pests. By Dr. J. S. Fitzgerald. Pp. 27. (Melbourne: Government Printer, 1944.) [26  
Andhra University. Publication Series No. 31: Natural Resources of the Andhra Area, and Allied Topics. A Symposium of Papers read before the Indian Academy of Sciences Sixth Annual Session (1940), Waltair. Pp. iv+152. (Guntur: Andhra University, 1945.) 2.8 rupees. [26  
Indian Central Jute Committee. Technological Research Memoir No. 5: The Ballistic Work of Rupture of Twisted Bundles of Jute Fibre and its relation to Spinning Quality. Pp. 18. (Calcutta: Indian Central Jute Committee, 1944.) 8 annas; 9d. [26



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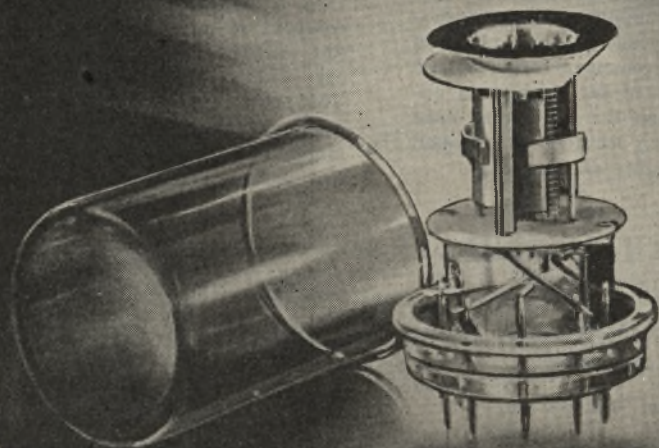
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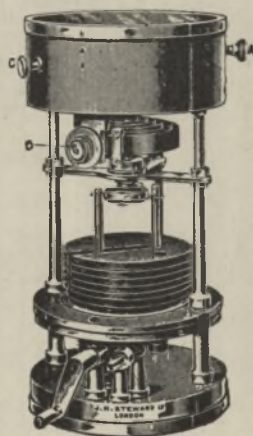


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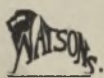
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