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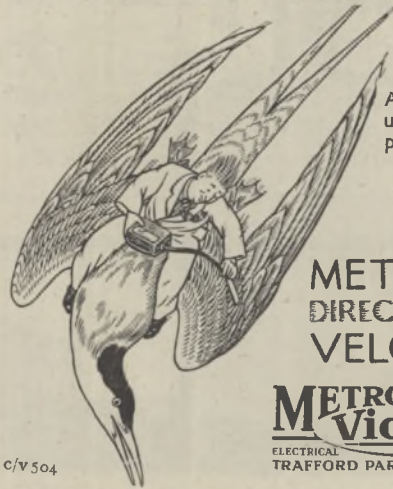
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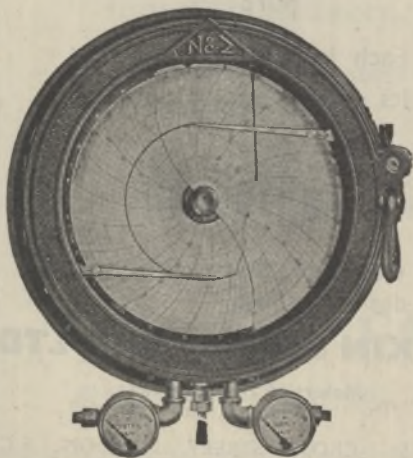
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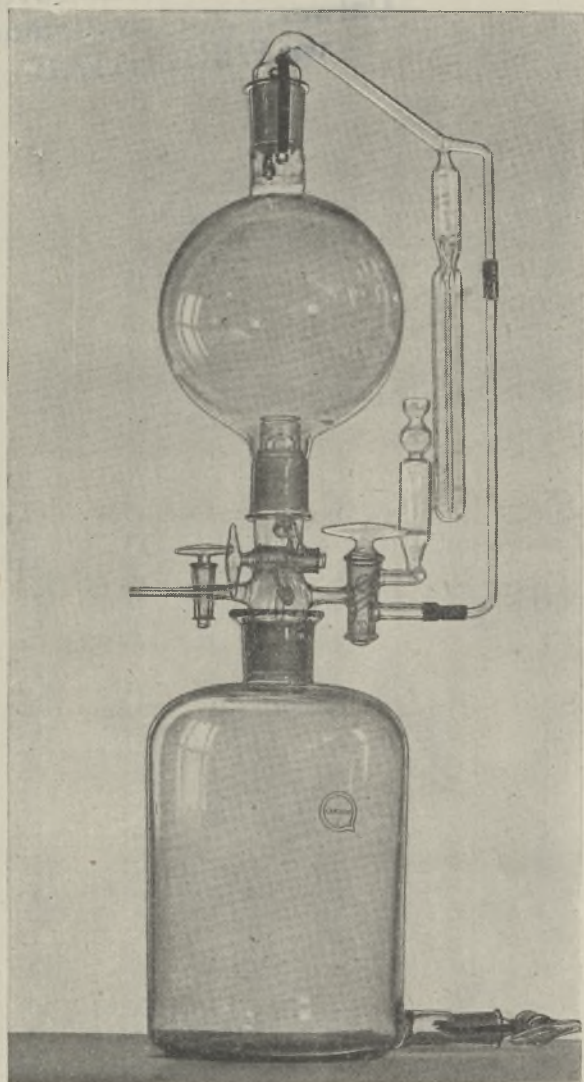
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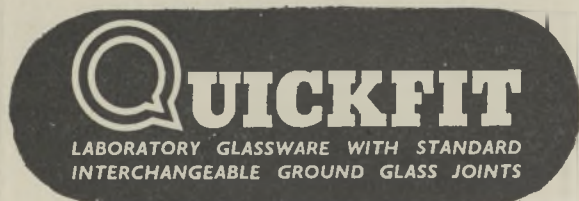


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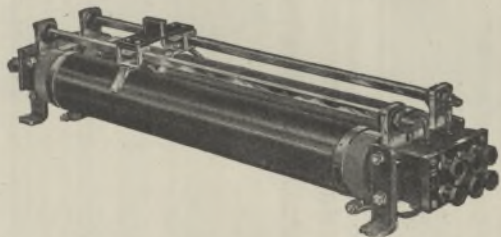
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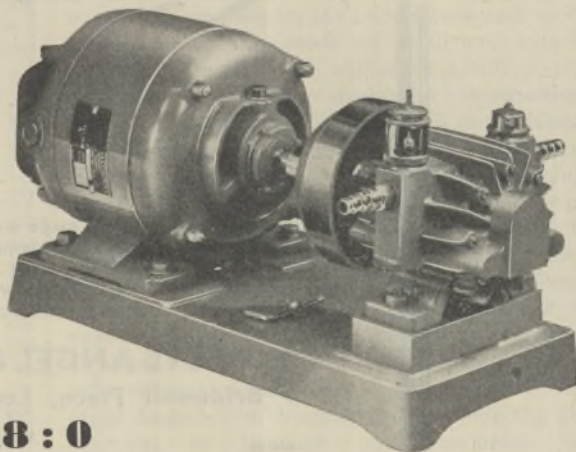
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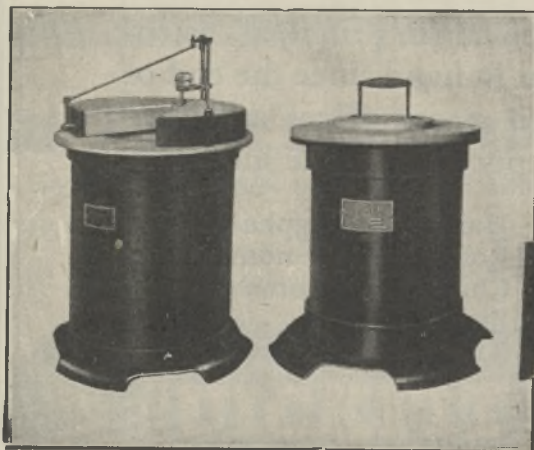
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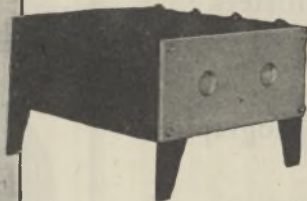
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# NATURE

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## COLONIAL UNIVERSITIES AND THEIR FUNCTIONS\*

IN the second part of its report, the Asquith Commission surveys in considerable detail the special problems involved in the provision of professional and vocational courses in the universities and university colleges, and the needs of medicine, agriculture, veterinary training, law, engineering, and the training of teachers; and the medium of instruction and linguistic training are discussed in a series of chapters with appropriate recommendations. These include, for example, the establishment of medical schools to serve those Colonial regions which do not now possess them, and refer to the fruitful opportunities for research which medicine presents in the Colonies; but like the Goodenough Inter-Departmental Committee on medical schools in Britain, the Commission recommends that medical schools should be integral parts of universities, and that full participation in the life of universities and close association with those following other branches of learning will provide the greatest stimulus to teachers and encourage medical students to develop those qualities of mind and character which go to the making of good medical practitioners. There is sage counsel on the functions of universities and university colleges in agricultural education, and a clear conception of the contribution of the university to agricultural education through its extra-mural activities, the importance of which is also well brought out in the first part of the report. The exceptional importance of veterinary training is recognized, and also the value and limitations of civil engineering, instruction in which up to B.Sc. standard in Colonial universities or colleges is recommended, although it may for a time be difficult to provide in the Colonies either the practical experience of good engineering work or facilities for fundamental research.

On the training of teachers, the Commission recognizes that, while it may for many years be impracticable to require that all teachers in the secondary schools shall be graduates, teachers in the higher and middle forms should be graduates. The university should concern itself primarily with the training of intending teachers who have already graduated, and with other teachers required for secondary schools. Recommendations as to the type of instruction are included; the department of education should be under a professor, and should be a centre of research in the many problems of school education in Colonial conditions; while in organizing the department of social sciences in the faculty of arts, the university should provide for research into linguistic problems to be pursued in close association with the departments of anthropological and sociological studies.

The third part of the Asquith Commission's report summarizes the report of the West Indies Committee and endorses its recommendations. As already noted, the chief of these is the establishment of a single University of the West Indies at the earliest possible date. The first step should be the founda-

\* Continued from p. 347.

tion of a university college, which, in order to establish its academic standards and win public confidence and esteem, should work for the most part for the external degrees of a university of repute. After a short period of apprenticeship, the college would obtain a charter and begin its autonomous life, providing initially for some 400-500 students, men and women. The Committee insists that the university should be a single centralized institution and entirely residential. Three years would be the usual period of residence and study to qualify for a degree, and the university should teach the basic subjects appropriate to degrees in arts and science, and should include a faculty of medicine. Provision should be made to enable as many students as possible to pursue in Britain or elsewhere such further professional and postgraduate training as may not be available in their own university. The university should also be the headquarters of an important department of extra-mural studies through which its influence would be projected into all the West Indian Colonies. The Secretary of State for the Colonies has just announced that the proposal has his full support, and that he is prepared to consider making a grant under the Colonial Development and Welfare Act towards building costs.

The arguments which lead to these findings reflect the whole spirit of the Asquith Report, with which the West Indies Committee report makes a coherent whole. The Committee was impressed with the strong evidence of the deficiency of technical education and the urgent need for skilled workers in nearly all branches of industry. There was a remarkable degree of local support for a unified institution, and the choice of Jamaica as site was reached last but independently by all members of the Committee. The same high conception of an educational system as a dynamic system inspires its report. The university is regarded as not simply enriching the fields of higher learning, but also influencing deeply the whole system of education by returning into its service, among others, secondary school and training college teachers, and in many intangible and indirect ways affecting the attitude of the community as a whole towards education and learning. Further, the essence of a university is that it should be a community of men and women pursuing a wide range of studies, humane and scientific, so that a continuous process of mutual education and intellectual broadening goes on, outside as well as inside the lecture rooms and laboratories. The Committee's recommendations spring from its faith in the positive contribution that a university could make to all the Caribbean territories, which are now for the first time being brought into a co-operative relationship. The Committee believes that a university should be the intellectual centre of a region to which its own graduates may look for encouragement and refreshment, and which may also be a meeting-ground for all those pursuing knowledge at the higher levels. Finally, it insists that the university should be a centre for research as well as teaching, and envisages the university as the main centre of research into the physical and social problems of the whole region. Indeed, the chapter on

research, though shorter than that in the Asquith Commission's report, is nevertheless no less worthy of careful study.

Space does not permit further quotation from this discerning and admirably presented report, and reference can be made only to one other point. The problem of training in medicine is beset with difficulties as regards the immediate future, for the establishment of a complete faculty of medicine located at the seat of the university in Jamaica and working in association with the Kingston General Hospital can become operative only when the complete university scheme comes into existence. The need is urgent, and on investigating the possibility of providing a medical course in the West Indies which would function as an emergency measure until the university comes into full operation, the Committee recommends the adoption with some minor modification of Sir Rupert Brierecliffe's scheme for the establishment of a temporary medical school in Trinidad, working in association with McGill University, Montreal.

The report of the Elliot Commission is the longest of the three reports; but as already indicated, it is not unanimous, nor, save perhaps in passages of the minority report, is it inspired by quite the same clear conception of the university ideal. There is an able survey of the general and of the educational background of West Africa and a lucid description of the present institutions for higher education there; but in their discussion of the future development of higher education, of the supply and training of teachers, of medical and health education, including dentistry, of agriculture, forestry, and animal health, and of technical education, the majority seem sometimes to have lost sight of general principles and objectives in a mass of local detail. The general case for the creation of universities in the Colonial areas argued by the Asquith Commission is indeed fully endorsed. Moreover, the proposals of the majority to develop a new university college at Ibadan in Nigeria (including faculties of arts and science, with schools of medicine, agriculture, forestry and animal health) to serve the whole of West Africa; a development of Achimota College in the Gold Coast (including faculties of arts and science, and an institute of education) and a reorganization, on a new site, of Fourah Bay College, which will also serve the Gambia (to include courses in arts and science up to the intermediate level and a teacher training course) are supported by the three West African members of the Commission. These university colleges are themselves to be centres of research and to collaborate closely with research organizations in West Africa, and the guidance of the Inter-University Council for Higher Education in the Colonies proposed by the Asquith Commission is welcomed. Higher education is here also considered as an integral part of a complete educational system. But the minority report appears to be argued more closely from first principles. This report rejects the majority proposals as likely to impede the earlier provision of a full range of university facilities in the West African territories. This aim requires that any future university must have all the necessary material

facilities planned and provided without delay, with adequate staff of high calibre. The recognition outside West Africa of any university institution will depend not only on the quality of the teaching given to its students but equally on its research achievements. The minority also insist that no university institution can fulfil its purposes unless it is comprehensive in scope; students of a variety of faculties must work together in a single institution and share a corporate life; and lastly, no college aiming at university status can progress with any speed towards its goal unless the students entering it are adequate both in numbers and in equipment for university study.

It is on these principles, and particularly on the incapacity of the areas to supply an adequate flow of students able to pursue successfully degree courses within the period normally allocated to these courses in universities of Great Britain, that the minority dissent from the recommendations of the majority, although with much of the majority report they are in agreement. They are deeply impressed with the intense need for the development of studies in arts and science to the same level side by side. In their view, every endeavour should be made to build up a first-class scientific centre by concentrating scientific development at the West African University College at Ibadan, where co-operation with those working in medicine, animal health, agriculture and forestry will provide both the environment and impetus to the carrying out of much-needed scientific research, and at the same time will greatly aid research in these subjects themselves. They fear that the majority proposals to duplicate facilities in science will inevitably hinder the development of research both in science and in arts. They lay much stress on the development of post-secondary vocational education and the need for a wide extension and improvement of vocational and technical education in order that the schemes now being prepared by Colonial Governments under the Colonial Development and Welfare Act may be implemented. The majority report itself recommends the establishment of technical institutes for the dependencies of Nigeria, the Gold Coast and Sierra Leone, as well as the appointment of three technical officers to survey the existing facilities as a whole.

The minority report also recommends that each territorial college shall undertake the training of secondary school teachers, provide refresher courses for the non-graduate teachers of existing secondary schools, as well as a two-year course, following the school certificate course, for training primary school teachers; and the teacher training section of each college should experiment in the training of women teachers. Other proposals for a balanced educational policy include vocational courses for training social workers, a clear distinction between the training of social welfare workers, undergraduate study and postgraduate study and research. It is suggested that the territorial colleges should also act as extra-mural centres of the West African University College, and that it would be of advantage if the research headquarters of the Institute of West African Arts,

Industries and Social Science were situated at Ibadan, though experimental stations and local research units would be maintained by it in all territories. In addition to the schools of medicine, agriculture, forestry and animal health, the proposed Institute of Education and a West African School of Engineering should also be established at Ibadan. The responsibility of recommending the creation of further institutions of university rank in West Africa would fall on the Inter-University Council proposed by the Asquith Commission; but in general the minority report suggests that it will be best to establish wholly new institutions rather than to attempt to convert territorial into university colleges.

As already indicated, the ably argued conclusions of the minority of the Elliot Commission appear to be more in keeping with the trend of the Asquith Commission than those of their colleagues; but individually and collectively the four reports present the university ideal in a way that gives them permanent value. That ideal is seen in relation to the present needs of the Colonial territories, and on the whole the immediate action required is clearly delineated with a large measure of agreement. Equally unmistakable is the note of urgency which runs through all the reports. The importance of university education is never over-stressed: it is always seen as part of a balanced educational policy as a whole. But it is clear also that unless university development in West Africa and the West Indies and elsewhere is not undertaken as a matter of great urgency, progress to self-government and real partnership will be retarded; and further, the economic and social development of these areas, and the implementation of developments under the Colonial Development and Welfare Act and the discharge of our pledges to build up social and economic institutions and to develop natural resources in these territories, will be retarded. The proposals of these reports merit full and sympathetic consideration: they involve close co-operation with the universities of Great Britain, co-operation on which the former Secretary of State for the Colonies rightly laid stress as a two-way traffic enriching the home universities as much as it is to the advantage of the Colonial territories themselves.

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## THE EARLY HUMAN EMBRYO

### Ourselves Unborn

An Embryologist's Essay on Man. By George W. Corner. (The Terry Lectures.) Pp. xiv+188+8 plates. (New Haven, Conn.: Yale University Press; London: Oxford University Press, 1944.) 20s. net.

**A**LTHOUGH the embryonic development of man is one of the most copiously described of natural processes, until a few years ago there were several gaps in the story so far as it was known. The gaps, moreover, occurred at the most crucial stage, right at the beginning. Until a decade or so ago, the earliest known human embryos presented the picture of a minute vesicle, covered in villi and buried within

the thickness of the uterine wall, the body of the vesicle consisting of a spongy tissue containing two small cavities between which the embryo reposed in the form of a flat plate. It was hard to draw any convincing analogies between this structure and that of the presumably comparable stages of other mammalian embryos. The early human embryo seemed aberrant in almost all its features; few other mammalian embryos bury themselves in the uterine wall, and no others were known with a similar development of spongy tissue, which might be considered either endodermal or mesodermal.

Our state of ignorance about the structure and affinities of early human embryos was dependent, of course, primarily on the difficulty of obtaining material for study. The opportunity to search a human uterus for recently fertilized ova is not an everyday occurrence even in a large hospital, and when it does occur, the difficulty of finding the minute object is considerable. Specimens from man's nearer anatomical relatives, the monkeys and apes, should theoretically be easy to obtain by special breeding; but that, again, is a most expensive proceeding, much beyond the resources of most embryological institutes.

In recent years the financial difficulties have been overcome with the aid of the generous funds placed at the disposal of scientific workers in the United States, and the Carnegie Institution of Washington has bred a supply of embryos of the Rhesus monkey. These have been fully studied and the crucial early stages described by Heuser and Streeter and others. At the same time, by an organized search on an adequate scale, a considerable number of very young human embryos have been discovered and investigated at the same Institution. Dr. Corner, who has recently become the director of the Department of Embryology in charge of these studies, made them the subject of his recent Terry Lectures, which have now been published in book form. He has thereby provided an account, both authoritative and easy enough for even the layman to understand, of the most recent advances in this field of human biology.

The new human material, and the even more complete series of forms from the Rhesus, show clearly that man's development is by no means so extraordinary as it appeared. Although no free blastocyst has been found, the earliest known stages show that man passes through such a form in a more or less normal manner. We have material which illustrates the immediately following stage, in which the blastocyst first adheres to the uterine wall and then burrows within it; and the monkey material shows that in other Primates too a similar process occurs. The new specimens allow us to examine in much more detail the formation of the extra-embryonic spongy filling of the trophoblast, and although the process is by no means fully understood, and correct attribution of the tissue to mesoderm or endoderm still remains largely a matter of choice, it is at least certain that, in this process again, man is closely similar to the monkey and the ape.

Dr. Corner describes the most important features of man's early Primate embryology with great clarity, and illustrates them not only with simple diagrams, but also with some of the beautiful photographs which have been a feature of the publications of the Carnegie Institution. He is, perhaps, less successful in attempting to attach profound philosophical importance to these facts. The Terry Lectures are, of course, concerned with "building the

truths of science and philosophy into the structure of a broadened and purified religion", and a lecturer on such a foundation is specifically invited to step, for once, beyond the narrow confines of a rigid adherence to immediate appearances, and encouraged to exhibit the broader implications of his subject. History, however, has flowed on beyond the controversies in which the facts of descriptive embryology were sharp and dangerous weapons, and it is not easy now to make their import seem momentous. "In the foregoing pages," writes Dr. Corner, "I have outlined the evidence for two very weighty conclusions about the physical nature of man. The first of these is that he is an animal, a member of the Class of Mammalia, Order of Primates, and closely related to the apes and monkeys. The second is that the human body is not notably endowed with specialized anatomical features. . . ." One may admit that the conclusions are weighty; but it is difficult not to feel that the first at least is a commonplace. Dr. Corner's material is, in fact, of first-class scientific importance, as solid, incontrovertible data filling in a gap in the scientific picture; the attempt to 'write it up' as of immediate import to man's spiritual life leads to the interpolation of occasional passages which some readers may find jarring.

C. H. WADDINGTON.

## CLASSIFICATION OF RECENT PHILOSOPHY

### Process and Polarity

By Prof. Wilmon Henry Sheldon. Pp. xvi+153. (New York: Columbia University Press; London: Oxford University Press, 1944.) 13s. 6d. net.

THIS, the first of the Woodbridge Memorial Lectures, is a fine tribute to an American thinker recently dead, by one who shares a great deal of his philosophy and even more of his eminently civilized and humane attitude, his wide sympathies and his felicity of exposition. Prof. Sheldon classifies what he considers the important tendencies of recent philosophical thought, though without despising or distorting them, so as to bring out their relationship with his own views. His view of the nature of the opposition between rival philosophies is that each describes a genuine and important aspect of the world or general tendency of things, while apt to neglect others. Philosophers are generally right in what they assert, but wrong so far as they deny the reality or importance of the neglected aspects. Thus 'idealism' expresses the aspirations and insight of men as moral agents; 'materialism' the basic facts of existence, which the idealist despises (perhaps rightly) but ignores to his cost. Older attempts to effect a synthesis of these two extremes he calls 'scholasticism'—a recognition of the reality of both material and ideal as each playing a complementary part in an eternal divinely ordered scheme; for the scholastic order is fixed, reality eternal and temporal process entirely subordinate. Many recent thinkers (including the author) attempt a synthesis in terms of process, incremental change or evolution. Prof. Sheldon includes also in his scheme mysticism and scepticism, which are opposed in another dimension, as it were; and distinguishes two divergent forms of idealism, monistic and pluralistic.

Prof. Sheldon is a pragmatist so far as he takes



thought to be essentially that which issues in action and is thereby put to the test; but he avoids the errors that come from despising reflective thought and from taking a commercial view of the ends of action. His statement (p. 22) that the full development of mental process requires all three phases, cognitive, æsthetic and practical, could scarcely be bettered. If this exposition could be taken as a preliminary sketch and the classification of philosophies as schematic and limited to the purpose of defining his own view, there would be nothing to find fault with. But apparently it is intended to be complete. Other types of opposition in thought, excluded from the classification, are dismissed as unimportant, ingeniously but not convincingly. The classification covers best those recent minor thinkers who fit readily into 'schools', but scarcely any of the great thinkers. The Greeks do not fit in; nor do Descartes, Spinoza or Kant. Excessive use is made of the ambiguity of the terms 'idealism' and 'materialism'. The notion of progress as change in any determinate direction is turned too easily into that of change which meets with our moral approval. Lastly, there seems no reason why those who recognize the importance of temporal process or progress in any sense should agree on anything else. There is as much difference between Herbert Spencer, Bergson and Prof. Sheldon as between any three philosophers taken at random.

A. D. RITCHIE.

## THE ANIMAL IN HEALTH

### Physiology of Farm Animals

By Dr. F. H. A. Marshall and E. T. Halnan. Third edition. Pp. xi+340. (Cambridge: At the University Press, 1945.) 18s. net.

WHILE most text-books on animal physiology are written from the point of view of the treatment of diseased conditions, this book by Marshall and Halnan is exceptional in that its object is the teaching of physiology as a basis for the management of the animal for production, normal health and growth. Animal physiology forms the fundamental science on which the teaching in the breeding, feeding and management of farm animals should be based. In the past, teaching in this sphere has been almost entirely based on practical animal husbandry rather than on the basal science. The science of animal physiology should in the future stand in the same relation to animal production as the science of botany has in the past stood as a basis for teaching in crop production in agricultural colleges. With the increasing demand for knowledge in the field of applied science and with the present emphasis on the livestock side of British agriculture, the new edition of this book, which has been out of print for some time, should supply a need for agricultural students and others interested in farm animals.

Naturally the functions of nutrition, reproduction including milk secretion, growth and locomotion find a larger place than in most text-books of physiology. In this respect it more nearly resembles the text-books of physiology of some sixty years ago. The present edition has been thoroughly revised and includes the results of recent investigations, particularly in the fields of nutrition and reproduction. The chapters on the energy requirements of the body, metabolism of organic and ash constituents, and feeding standards include much useful information on

the results of modern research and are presented in a clear and simple form. A chapter on digestion and other facts concerning the fowl, so frequently neglected in modern books on physiology, is included. Similarly, the chapters on the male generative organs, the female generative organs including the mammary gland, and growth give the essential facts elucidated by recent research in a form which can easily be grasped by the student.

In detailing these results the research worker's name is given, but one misses, however, a short list of references to outstanding papers, books and reviews of the subject, which would enable the reader to continue with advanced study in any particular aspect in which he might be interested. The large number of illustrations makes the book particularly suitable as an introduction to the subject for the agricultural and veterinary student. JOHN HAMMOND.

## A TEXT-BOOK OF HEAT

### A Text-Book of Heat

By G. R. Noakes. Pp. viii+469. (London: Macmillan and Co., Ltd., 1945.) 10s. 6d.

TO his successful volumes on optics and on electricity and magnetism, Mr. Noakes now adds a comprehensive text-book on heat "up to scholarship standard". Instead of taking the material of the older books, correcting obvious errors and including new matter merely with the object of securing encyclopædic completeness, he has wisely chosen the more philosophic plan of examining critically current ideas on the subject, in order to present them in such a way that the young physicist may receive a sure grounding in fundamentals rather than make an acquaintance with an excessive range of isolated facts and opinions.

Guided by his wide teaching experience, the author has deemed it necessary to challenge much that has become almost sacrosanct by dint of uncritical repetition in the past. Thus, definitions have been examined and often found wanting in precision; experimental results have been reviewed as to their meaning and application and, with characteristic and commendable boldness, old and inaccurate methods of measurement (the only claim of which to value was the doubtful one of respect for teaching traditions) have been omitted or relegated to a mere note in favour of up-to-date working practice hitherto scarcely touched upon in text-books of this standard.

The treatment throughout is highly original and stimulating. Physics teachers will take special delight in the presentation of thermometry, calorimetry, kinetic theory of gases, transference of heat and thermodynamics. The chapters on low temperatures and heat processes in the atmosphere provide a valuable survey of recent research in fields that have become of great importance to everyday life; indeed the realistic outlook of the whole volume, coupled with its sound statement of fundamental principles, would seem to render it a fitting guide to the 'heat' section of the course for the new National Certificates in Applied Physics, and to this end it may be strongly recommended to technical teachers.

Practising physicists who desire a refresher course in classical physics will find the volume both entertaining and instructive, especially if they attempt some of the searching numerical examples provided for exercise.

## A NEW COSMOGONY OF THE SOLAR SYSTEM

FULL details of a new theory of the origin of the planets have now reached Great Britain from Sweden in a series of papers published by Dr. Hannes Alfvén in the past three years. The main theory is given in two of these papers<sup>1</sup>, though references are made in these to preliminary work appearing in other Swedish periodicals.

Previous cosmogonies of the planetary system have started with some premise (more or less likely according to the state of knowledge at the time) as to the original spatial distribution, velocity and physical condition of the matter later to form the solar system, and of any neighbouring material required by the theory. The subsequent history of the matter is then decided by calculating the gravitational and other mechanical interactions involved, using the accelerations thus deduced to predict for the present time a new spatial distribution which should, of course, approximate to the present state of affairs. Dr. Alfvén breaks new ground by considering not merely the gravitational but also the electromagnetic interactions. Ions and electrons within the planetary system, he claims, are affected very much more by the sun's general magnetic field than by its gravitational field; and since at the time of genesis of the system the planetary matter is likely to have been at least partially ionized, it is probable that electromagnetic forces have been more important than mechanical forces in shaping the system as we see it to-day. From a study of the motion of ions in the solar magnetic field, he is led to attribute the formation of the planets to the passage of the sun through an interstellar cloud or series of clouds—a circumstance which, incidentally, is not so intrinsically unlikely as the close approach of another star required by theories of the 'catastrophic' type. Alfvén claims that in these conditions matter will accumulate in the equatorial plane at about that distance from the sun at which the present major planets are found. From this starting point he is able to explain many features of the solar system, even down to such details as why Saturn alone has rings, and why the rings show their observed structure.

It is relevant to recall here that the main difficulty encountered by cosmogonies of the Laplace type—the nebular hypothesis and its many modifications—concerns the peculiar distribution of angular momentum among the bodies of the solar system. A uniform discoidal nebula contracting from planetary distances would result in a system in which the main angular momentum was possessed by the central body, and no appeal to the effect of viscosity in redistributing it has yet convinced astronomers that this agency can convey 98 per cent of the momentum from the sun to the planets. On the other hand, a strongly condensed nebula of which the outer portions contain initially only enough mass to make the planets cannot in fact form planets at all. The tidal theory in its many forms also suffers from this difficulty. The encounter between the sun and a passing star postulated on this theory must be sufficiently close for tidal eruptions to eject enough planetary matter to form the solar system. But, as Russell has pointed out, it is then impossible (by a factor of the order of ten) for the planets to obtain their angular momentum at the intruder's expense. Furthermore,

there is as yet no agreement as to the form taken by the filament of matter tidally extracted, or even whether it will dissipate or condense. The other time-honoured objection to tidal theories is the low probability of a close encounter. Now it is not a valid objection to an encounter theory that encounters are improbable: they may nevertheless happen, and all the objectors can justifiably claim is that planetary systems will be correspondingly rare. The discovery of non-solar planets<sup>2</sup> militates against this view. It is perhaps not an unfair summary of the present situation to say that those hypotheses which can claim an end-product most like the present solar system are precisely those which introduce the greatest number of *ad hoc* assumptions. Clearly, this is an unsatisfactory state of affairs.

In these circumstances, Dr. Alfvén roundly asserts that at the genesis of the solar system some kind of force must have been in action which is not taken into account in present theories. He believes that this force is the action of the general magnetic field of the sun on charged particles of primeval matter in motion in the solar neighbourhood, and his theory is an elaboration of this assumption.

In a preliminary paper<sup>3</sup>, Alfvén has given reasons for believing that if a cloud of ionized gas invades the magnetic field of a rotating electrically conducting sphere, currents will be induced in the gas which will interact with the magnetic field so as to accelerate the ion cloud and retard the rotation of the sphere, thus tending to equalize the angular velocities. Applying this to the solar rotation, he comes to the conclusion that the time needed for this process (approximately  $10^6$  years) is very much smaller than the currently accepted age of the solar system, and thus that the transfer of angular momentum by this means is worthy of consideration. A further point of interest is that the rate of retardation is expected to increase with heliographic latitude, so that the non-uniform rotation of the sun observed at present may be due to this braking process in a past so distant that the planets have had time to form and acquire most of the original angular momentum, yet not so distant that solar viscosity has been able to equalize the solar rotation in all latitudes.

The theory starts, then, with the sun a single star in much the same condition as at present, save for a faster rotation. At the outset it enters a gaseous nebula consisting of neutral atoms with peculiar velocities corresponding to the temperature of interstellar space. These atoms begin to fall in under the sun's gravitational field, exchanging their potential energy for kinetic. At a distance  $r$  from the sun, the kinetic energy of an atom produced by gravitational attraction is

$$E = GM_{\odot}Am_H/r,$$

where  $G$  is the constant of gravitation,  $M_{\odot}$  the sun's mass,  $A$  the chemical atomic weight, and  $m_H$  the mass of unit atomic weight. Mutual collisions between the atoms will result in a rising 'temperature' corresponding to this kinetic energy as  $r$  decreases; this process is similar to the heating by gravitational contraction suggested nearly a century ago by Helmholtz as the energy-producing mechanism in the sun. At a distance  $r_i$  from the sun, which depends on the atoms concerned, this energy becomes equal to the ionization energy  $eV$  (where  $V$  is the ionization potential). At this distance,

$$r_i = GM_{\odot}Am_H/eV,$$

the gas becomes ionized. Thence the system of forces

is completely transformed. Electromagnetic forces come into play which are usually larger than the gravitational attraction, and the ions are repelled, spiralling away from the sun around the magnetic lines of force. Meanwhile, the process mentioned above begins to cause rotation about the sun's axis. A neutral gas falling into the sun from interstellar space is thus stopped at about the distance  $r_c$  from the sun. It is obviously interesting to calculate this distance for a hypothetical material. If  $A = 7$  and  $V = 12$  volts (values not unreasonable for planetary material)  $r_c$  is found to be  $8 \times 10^{13}$  cm., a value close to the radius of Jupiter's orbit. This is, of course, a drastic schematization of the actual conditions, for different atoms will be stopped at different critical distances; but it does serve to indicate that a gas cloud will tend to accumulate at about the distance from the sun of the major planets.

Atoms which become ionized on the spherical surface  $r_c$  can move only on the surfaces engendered by rotating the magnetic lines of force around the axis of the sun<sup>4</sup>, for on account of their low kinetic energies they are constrained to perform close spirals around the lines of force, while rotating also about the solar dipole. Alfvén shows that, so far as its average trajectory is concerned, each particle may be replaced by an 'equivalent magnet' of moment

$$\mu = AmHv^2/2H,$$

where  $v$  is the velocity of motion perpendicular to the line of force and  $H$  is the local field strength. This equivalent magnet is acted upon by a force  $-\mu \text{ grad } H$  due to the non-uniform field, the minus sign indicating a repulsion down the magnetic gradient. For a given particle, stable equilibrium is possible only where its line of force cuts the equatorial plane; so that from the initial spherical shell of constant density the ions move to the equatorial plane, building up a disk of variable density by projection along the lines of force. Alfvén calculates the density distribution to be expected, and by assuming that all the material between the radius  $r_c$  and the orbital radius of Saturn has condensed into Jupiter, and all that between the orbits of Saturn and Uranus has condensed into Saturn, and so on, he obtains the following relative masses to be expected for the outer planets:

	Mass (Earth = 1)	
	Calculated (317)	Observed
Jupiter	87	95
Saturn	26	15
Uranus	10	17

The condensation process he invokes is one suggested by Lindblad<sup>5</sup>, which depends on sublimation due to the great difference of temperature between the interstellar gas and solid particles. The process is favoured in the relatively dense accumulation in the equatorial disk, and may possibly occur after recombination of the ions in that neighbourhood. After recombination, only gravitation affects the particles, which then revolve in orbits of eccentricity  $1/3$  with their accrued angular momentum. Collisions then transform these orbits into a circle of radius equal to  $2/3$  of the distance at which recombination occurred, a fact which Alfvén later uses to explain much of the detailed structure of Saturn's rings and the asteroids.

The agreement in order of magnitude shown in the table above encourages an attempt to apply the same reasoning to the planetary satellites. If after forma-

tion of the outer planets some of the gas cloud remains uncondensed, and if the newly formed planets become magnetic dipoles, the process is likely to recur on a smaller scale. The residual gas will be attracted by the gravitational fields of the planets, will fall in towards the parent bodies and become heated, ionized and then stopped at certain critical distances by the magnetic fields. It is significant that in the case of Jupiter this critical distance is of the same order as the orbital radii of the Galilean satellites. With Saturn the critical distance is within the Roche limit, so that the material which would otherwise form the first satellite (the analogue of Jupiter in the solar system or of Io in the Jupiter system) cannot condense at all and forms the spectacular ring system. With Uranus and Neptune the mass is so small that the critical radius is of the order of that of the planet itself, so that neither satellites nor rings would be expected as a result of the primary process.

The theory thus accounts qualitatively and even, in some respects, quantitatively, for the observed mass distribution in the outer planets and their inner satellites—the first family, as Alfvén calls them. There remains the question of the second family: the terrestrial planets and the outer satellites of the outer planets. It is possible that the latter are the result of the primary process acting on those constituents of the interplanetary nebula which have high atomic weights or low ionization potentials (or both). It is sufficient to make  $A = 30$  and  $V = 9$  volts to get numerical agreement between the theory and observation. In this connexion it is satisfactory to note that the densities of the outer satellites of Saturn are considerably higher than those of bodies in the first family, whether planets or satellites. But to explain the formation of the inner planets on the theory as given above is impossible. Even for hydrogen,  $A = 1$  and  $V = 13.5$  volts, giving  $r_c = 10^{13}$  cm., so that penetration inside the orbit of Venus is impossible. At best, Mercury would be non-existent and Venus a mass of pure hydrogen!

As a working hypothesis offering a way out of this difficulty and accounting simultaneously for both the planets and the satellites of the second family, Alfvén suggests that the primeval material from which the inner planets were formed consisted of solid particles resembling meteoric dust. These can penetrate much closer to the sun than atoms: for unlike gas ions, dust particles will be practically unaffected by the general magnetic field, which will take effect only when the particles are near enough to be partly volatilized. If volatilization and ionization occur in the region of the inner planets, the ions will be repelled at once along the inner lines of force and will accumulate in the equatorial plane and start rotating exactly as in the formation of the first family. Hence the terrestrial planets. A small proportion approaching the sun's poles will be repelled as far as the outer planets and on recombination will form satellites distinguished from those previously considered by the high value of  $A/V$  characteristic of meteoric matter, and thus by larger values of  $r_c$  than first-family members. Alfvén identifies this family with the outer moons of Jupiter and Saturn and the satellites of Uranus and Neptune. For  $A/V \sim 5$  volt<sup>-1</sup> the critical distances  $r_c$  are of the right order; and this value is not unlikely if meteorites reaching the earth are typical in their chemical composition (oxygen, 1.2; iron, 7.2; silicon, 3.5; magnesium, 3.2).

Further development of the theory enables Alfvén to explain in some detail certain features exhibited in the densities and axial rotations of the planets and their satellites; but enough will have been said here to give the broad principles of the theory he has advanced. Two circumstances militate against its widespread acceptance at present. First (and this applies to any cosmogony) the nature of the problem is such that any theory must be developed from premises which are largely guesswork, and can have few points at which direct observational checks can be applied. Second, during the past six years international exchange of scientific periodicals has been in so chaotic a condition, and so few astronomers have been free to conduct abstract studies, that much potential criticism has yet to be formulated. The end of the War in Europe will, no doubt, quickly remedy matters in respect of this second point, but the first will remain. Alfvén's hypothesis cannot hope to escape the criticism which has been so freely bestowed upon its predecessors. For example, its very basis, that the sun possesses a general magnetic field, has in another connexion been challenged from the observational point of view<sup>6</sup>. Furthermore, calculation of the trajectories of charged particles in non-uniform fields is not an elementary matter, and Alfvén's treatment of the problem may be attacked. But he will have performed a valuable service to astronomy if this series of papers can establish that electromagnetic forces have in the early stages of the solar system played a part even comparable with those mechanical forces which have hitherto been the only ones considered.

A. HUNTER.

<sup>1</sup> Alfvén, H., *Stockholm Obs. Ann.*, 14, No. 2 (1942); No. 5 (1943).

<sup>2</sup> Hunter, A., *Nature*, 152, 66 (1943).

<sup>3</sup> Alfvén, H., *Ark. Mat. Astr. Fys.*, 28, A, No. 6 (1942).

<sup>4</sup> Alfvén, H., *Ark. Mat. Astr. Fys.*, 27, A, No. 22 (1940).

<sup>5</sup> Lindblad, B., *Nature*, 135, 133 (1935).

<sup>6</sup> Evershed, J., *Mon. Not. Roy. Ast. Soc.*, 99, 430 (1939).

## THE SCAPEGOAT IN MODERN EUROPE

IN view of the important and unhappy part played by scapegoats in the political field in recent years, the general theme of the scapegoat in modern Europe was a well-chosen one for a joint meeting of the Royal Anthropological Institute and the Social Psychology Section of the British Psychological Society held in the rooms of the Institute on July 3, Prof. Daryll Forde being in the chair. It was perhaps unfortunate that most of the speakers allowed themselves great latitude in the interpretation of the subject, with the result that less light was thrown upon contemporary aspects of scapegoatism than might have been hoped for. Nevertheless, the great significance of the theme in human history and culture was well illustrated by the discussion, as was also the amazingly wide range of social phenomena in which it may play a part.

Dr. J. C. Flugel, in opening the discussion, outlined his view regarding the general nature of the psychological processes involved. The use of scapegoats involves the general process of 'displacement', 'substitution' or 'deflexion', that is, the transference of an impulse from one object to another in virtue of association or conditioning, the particular kind of displacement here involved being the projection of

aggression, guilt or suffering. It is theoretically possible to distinguish between the transference of simple misfortune (for example, barrenness or disease) and of guilt; but in practice the distinction is often difficult, since misfortune is often regarded as itself in the nature of a punishment for guilt, and the use of a scapegoat is then only a means of shifting the burden of punishment. In the view of many psychologists, the spirits or demons that in primitive beliefs are responsible for so many human disasters are themselves mental creations due to the projection of human aggressiveness, which in this form recoils on those in whom the aggressiveness originated.

A full psychological understanding of scapegoatism thus necessitates a consideration both of projection and of the role of punishment. Projection (the attribution to others of qualities in ourselves) arises from, and in some sense perpetuates, the confusion between the self and not-self to which child psychologists have directed attention, a confusion to which in some measure we return as we fall asleep or dream and which can even be experimentally induced by the adoption of certain attitudes (as in Spearman's interesting 'experiments in objectivating'). Projection is also due in part to the general tendency to establish the equation: 'good'=self, 'bad'=not-self. The child soon discovers that what is 'bad', that is, painful, disturbing and (later) 'naughty', can often be dealt with either by destroying the 'bad' outer object or removing himself from it, whereas when the 'bad' is within the self, either in the form of unpleasant bodily sensations or mental uneasiness or guilt, there is no such possibility; hence there arises a natural desire (in virtue of a primitive form of 'wishful thinking') to place everything that is 'bad' in the category of the not-self. Projection is complementary to introjection (the attribution to the self of qualities of persons or things in the outer world) and the child-analysts consider that the two processes—one following the other in long alternating sequence—play an important part in mental development. Projection is also allied to such processes as these in virtue of which a man identifies himself with his children, family, possessions or country (W. James's 'extracorporeal' or 'social-selves') or finds a vicarious satisfaction in the triumphs or enjoyments of others (Anna Freud's 'altruistic surrender'). The projection of aggression in a form relevant to the theme of scapegoatism is clearly seen in many childish phobias, where the bogies feared (for example, fierce animals or ogres) owe their terrifying qualities to the child's own aggressive impulses. There is good reason to suppose that the psychological process here is fundamentally similar to that involved in the alarming features of the primitive animistic beliefs in demons and evil spirits already referred to. Projection of the same kind is also at work in delusions of persecution or jealousy, where the patient's own 'evil' wishes are attributed to the supposed persecutors.

Turning to punishment, Dr. Flugel said that this is a fundamental method of dealing with guilt. There is in the human mind a deep tendency to expect, and indeed to demand, that guilt should be atoned for by punishment, though in virtue of projection the punishment can sometimes be suffered vicariously by a scapegoat. Some persons are more inclined to blame, and inflict punishment on themselves, others to project the blame and inflict vicarious punishment. On the basis of recent experimental studies, these have been called by Rosenzweig the 'intro-punitive' and 'extra-punitive' types respectively. Minor forms of

scapegoatism can be seen in children's play and fantasy, where dolls or 'imaginary companions' can get into scrapes and receive appropriate punishment of a kind which may previously have befallen the children themselves; the 'bad' impulses are here projected on to the toys or fantasy-figures. In adult life the same tendencies may manifest themselves in scandal-mongering, in purity campaigns, in our attitude to criminals and in educational practice. In all these cases the persons blamed or punished are guilty of actions to which we ourselves are to some extent tempted, and in administering censure or punishment on the scapegoats, we are also putting things right with our own conscience. A great advantage of the use of scapegoats is that we can feel virtuous ourselves. In the field of religion there is the important category of divine scapegoats who are sacrificed to atone for guilt. It is at first sight strange and paradoxical that so many sacrifices to a god are also sacrifices of that god (in direct or symbolic form). A further but connected problem is raised by the fact that in these cases the scapegoat is 'good'. The solution of both problems is probably to be found in the existence of 'ambivalence' on the lines indicated by Freud in his theory of totemism.

Finally, there is the class of political scapegoats who have played so great a part in recent years. Hitler, in accusing the Jews of seeking world dominion, was, of course, projecting on to them his own desires, and in so doing succeeded in making the Nazi designs appear supremely righteous to himself and his followers. Quite generally, the use of political scapegoats is a potent means of disposing of the aggressive impulses in the members of a group without disrupting the group. Indeed, by attributing every kind of evil design to the scapegoat and thus apparently necessitating a united front against him, this psychological device can greatly increase the internal cohesion of the group. Hence the great and sinister role taken by the scapegoat motif in inter-group conflict throughout human history.

Dr. M. A. Murray, who was the second speaker, confined herself to two main themes: the relation of the scapegoat motif with fertility, and its manifestation in the death of political scapegoats during a certain period of English history (from Edward I to the end of the Stuarts). Scapegoats, she suggested, were found only in agricultural, not among pastoral, peoples. There are at bottom three origins of the idea of the scapegoat: (1) Sin causes barrenness of the soil; in order to avoid this calamity the sins of the community are laid on one person, who is killed or driven out. (2) The spirit of fertility becomes incarnate in a man (the 'god-box'). If this man grows weak or dies, fertility will diminish or disappear; therefore the 'god-box' must be killed with due ceremony while still strong, and the spirit put into a young and lusty 'god-box'. (3) Life is taken out of the ground by the crops, therefore life must be given back to the ground. This can be done by pouring the blood of the victim on the ground, by burning him and strewing his ashes on the ground, and by asphyxiation, when the body is dismembered, the pieces of his flesh being distributed over the land (connected with the custom of drawing—in the sense of disembowelling—and quartering the body of a traitor or criminal).

The spirit of fertility is most naturally incarnated in the person of the king or ruler—for whom, however, a substitute or scapegoat can be found. (A relic of this is to be found in the English coronation ceremony at the moment when the king, after the anointing,

stands alone divested of his outer robes and clad in white, while those officiating step away from him.) In the course of time this whole process is apt to become stylized and connected with certain cycles (mostly seven- or nine-year cycles), the origin of which is still far from clear, though there is no doubt it is of great antiquity. The sacrificial months of the Old Religion (which Dr. Murray calls the 'Dianic cult') were February, May, August and November. The right days for the sacrifice were February 2, May 1, August 1 and November 1, though these were not always observed when the custom began to die out. The periodic sacrifice most marked in English history is that of the seven-year cycle. The victim was slain when the king's age had reached a multiple of seven years (personal victim), or when his reign had reached seven or a multiple of seven years (regal victim). Among notable victims might be quoted:

William Wallace, Mock King. Executed August 23. Edward I's age, twenty-one.

Piers Gaveston, Mock King. Surrendered to the barons on condition that no harm should happen to him until August 1. Beheaded. Edward II's age, twenty-eight.

Duke of Clarence. Murdered (in a butt of malmsey?) February 18. Edward IV's age, thirty-five.

Perkin Warbeck, Pretender to the throne. Executed November 23. Henry VII's age, forty-two; reign, fourteen.

Cardinal Wolsey. Died November 29. Henry VIII's reign, twenty-one.

Dr. Murray suggested that the fact that there was always a victim in England upon whom the people could vent their sense of guilt at periodic intervals may be a cause of the tolerance which is so marked a feature of the English as compared with most other nations.

Further to the subject of national differences, Dr. Margaret Loewenfeld, in opening the general discussion, remarked on the differences in the attitude of various cultures to the expression of feeling. Although in Britain emotion is often considered disreputable, members of other cultures (for example, in their different ways France and Germany) might feel they have a right to certain emotional experiences (such as that implied in 'thinking with the blood'). In such circumstances those who do not feel in the same way become an out-group, and in time of frustration it is inevitable that the out-group should become a scapegoat. She illustrated this by reference to the Suffragette movement and the attitude of members of the Stock Exchange to 'bucket shops'.

Dr. Ernest Jones emphasized the importance of distinguishing between scapegoatism and simple aggression. The Nazi use of the Jews as scapegoats probably depended largely on the fact that Germans were at bottom disturbed by the imputation of war guilt; but instead of resorting to sackcloth and ashes (as the ancient Hebrews might have done) they projected their guilt. We may, he said, never have another such opportunity of studying scapegoatism on the grand scale, and he was disappointed that the discussion had not dealt more in detail with recent events. He suggested further that the Germans did not look for scapegoats so much among their foreign enemies as among themselves, and found them among their own Jews and Communists. This may be connected with the fact that, as psycho-analysis has shown, the child builds up an idea of good or bad 'internal objects'. In answer to a question, he admitted the feeling against international Jewry, but he thought this might be only because there are German (or English, etc.) Jews.

The distinction between guilt and simple aggression was further brought out in the remainder of the

discussion, which dealt, among other things, with the guilt feelings of Britons and Americans at not being adequately prepared for Nazi or Japanese aggression, with the fact that the chosen scapegoat need not necessarily be innocent as judged by rational standards, and with the possible existence of rudimentary guilt and scapegoatism in animals.

## THE ATOMIC BOMB

**A** PAMPHLET, "Statements relating to the Atomic Bomb", published by H.M. Stationery Office (price 4d. net), gives some account of the activity in Great Britain and the United States leading to the use of this weapon in Japan by the United States Army Air Force. Reference is made to statements issued by the United States and Canadian Governments giving an account of the work carried out in these countries which led up to or was associated with the achievement, and an outline of the scientific background. The statement includes a brief summary of earlier work on nuclear disintegration which bears only indirectly on the phenomenon of nuclear fission, on which the activity of the atomic bomb depends, and then gives some account of the work on the fission of uranium nuclei, published prior to the beginning of the War, and the development of which on a large scale led to the atomic bomb.

In 1934 Fermi and his colleagues in Rome subjected uranium to neutron bombardment and showed that new isotopes were formed which were radioactive, and it was thought that atoms of atomic number higher than 92, that of uranium, had been produced. These elements were not known in Nature. In 1938-39, however, Hahn and Strassmann, in Berlin, made experiments which showed that one, at least, of the new isotopes believed to be of higher atomic number and mass than those of uranium was really an isotope of barium, which had an atomic number and mass about half that of uranium. Frisch and Meitner thereupon pointed out that a phenomenon which they called 'nuclear fission' had occurred, the uranium nucleus being split into two parts of roughly equal mass, and that the two parts of the divided uranium nucleus should fly apart with great energy, a prediction verified experimentally by Frisch in Copenhagen. Confirmation of this fission process, and of the great liberation of energy, was independently obtained by Joliot in Paris, and by many other physicists.

Early in 1939, Joliot, Halban and Kowarski proved experimentally what had been predicted theoretically, that in the fission of uranium, a number of free neutrons were also produced, and independent confirmation was obtained by Anderson, Fermi, Hansstein, Szilard and Zinn in the United States. It was clear that the fission not only provided a large amount of energy by reason of the loss of total mass which had occurred, according to Einstein's theory of the correlation of mass and energy, but also that the liberation of neutrons in the process, which was produced by neutron bombardment, suggested that each time a uranium nucleus underwent fission, the reaction might be accelerated by the neutrons which it itself produced. It would, in fact, be analogous in the field of nuclear chemistry to the well-known chain reactions in the chemistry of stable atoms and molecules. The process could be started by the application of only a minute fraction of the energy which would ultimately be liberated.

Bohr and Wheeler had published a theory of the fission process in 1939 in which it appeared that the isotope of mass 235, present in only small amount in natural uranium, which consists mostly of the isotope of mass 238, should undergo fission particularly easily when the bombarding neutrons had a very low energy, whereas the isotope of mass 238 requires high-energy neutrons. This prediction was verified in 1940 by Nier, and by Booth, Dunning and Grosse, in the United States. Neutrons of an intermediate energy-range are strongly absorbed by the uranium 238 nucleus; but instead of producing fission, a new nucleus of mass 239 is formed. This has the property of emitting two electrons in succession, thus forming nuclei of atomic numbers 93 and 94, which do not occur in Nature. The nucleus of atomic number 94 should be capable of undergoing fission with the greatest ease when bombarded with neutrons of very low energy. The elements of mass 235, 238 and 239 are not the only ones which should undergo fission; thorium should undergo fission with bombarding neutrons of very high energy, and protactinium (mass 231, atomic number 91) should behave in a way intermediate between uranium 235 and 238.

The energy liberated in uranium fission is stated to be millions of times greater than that set free in the combustion of an equal weight of oil or coal; but the process must obviously be controlled, and a suitable 'slowing-down' medium is necessary, so that fast neutrons produced by fission would lose their energy by elastic collisions before producing further fission. Such a medium is provided by heavy water, or deuterium oxide. In an atomic bomb a quantity of uranium 235 greater than a certain critical amount is necessary. This is because the reaction depends on the conservation of the neutrons produced by the fissions. In a block of uranium, the proportion of neutrons which escape into the outer air, and thus become ineffective, is reduced by increasing the size of the block, and explosion is possible only with a certain minimum amount of material. Quantities less than this are perfectly safe. Thus, it is only necessary to bring together two pieces each less than the critical size, but exceeding it when in contact, to detonate the bomb. It is stated that the temperature of the mass then reaches many million degrees and the pressure many millions of atmospheres. The reaction must develop so rapidly that a substantial part of the material can react before the system has time to fly apart, and the neutrons produced in the fission process are fast enough to fulfil this condition, unless they are slowed down by artificial means.

Details are given of work at Liverpool and Cambridge on the dimensions of the bomb and related problems, and on the method of separation of the uranium 235 isotope by a gaseous diffusion method at Oxford and Birmingham. During this period, similar problems were occupying American scientific men. In 1942, it is stated, it became clear that the scale upon which research and development could be undertaken in the United Kingdom must be far smaller than in America. In 1943 a large research establishment was set up in Montreal, Canada, and in 1944 a British-Canadian-American project was in operation near Petawawa, Ontario.

The report gives the constitution of many committees set up, and of Government actions at various stages, and is a record of well-co-ordinated and actively prosecuted effort in the many directions necessary before the atomic bomb became a reality.

## ARCHIVES OF THE LAKES

WE are just now being made aware that there exists a remarkable series of records of the history of Europe throughout the whole period since the great ice sheets began to release their hold on the Continent. These records are entombed in the deposits of our lake basins. We have hitherto been unable to read these archives; but the methods of pollen-analysis have given us the clue to their broad interpretation, and the story of forest history, of climatic change, and of human activity is discerned with increasing clarity. We have learned from de Geer that these records can, in some circumstances, be accurately dated; the lake deposits sometimes indeed consist of leaves, one page laid down per year, so that a precise geochronology of the past ten thousand years or so has been placed in the hands of the archivist.

A glimpse of the remarkable wealth of information such records may disclose is afforded by the recently published work of Max Welten on the deposits of a single tiny filled-up lake basin in the Simmental in the western Bernese Oberland<sup>1</sup>. This *Faulenseemoos* lies at a height of 590 m. above sea-level, on the road between Spiez and Interlaken, and here M. Welten, a pupil of Dr. Lüdi in Zurich, has carried out co-ordinated research on pollen-analysis, stratigraphy, and geochronology. Twelve detailed pollen-diagrams, distributed along a profile of the lakelet's length, which is only about 500 m., give a complex but consistent picture of the vegetational history of the region round the lake, which has been steadily filling in throughout post-glacial and late-glacial times. The lake was oligotrophic only for a short while, and then rapid infilling took place from land surfaces laid bare by the glacial retreat. With complete vegetational cover of the countryside, however, the infilling became slower. Heavy deposits of lake chalk were made round the shallow margins while the deep centre deposits grew very slowly, and then, as the climate grew warmer, organic material formed too rapidly for total oxidation and nekron-mud (*gyttja*) was laid down. Thence followed a yearly periodicity of chalk deposition caused by influx of mineral-rich water in early summer, and of nekron-mud in autumn and early winter. Thanks to the small size and shelter of the lake, these annual layers were preserved in long series, and have permitted the construction of a geochronology which reaches to the present day. In terms of this all other stratigraphic, climatic and vegetational events have been dated. More also than this: the recognition of annual layering has permitted Welten to express his results in terms of absolute rates of pollen deposition per unit area of lake surface. He has thus provided the test we have long awaited, of the validity of the standards of reckoning, long accepted *faute de mieux*, such as grains per cent of the total tree pollen, or grains per unit area of microscopic preparation.

There has always hitherto been much room for doubt how far the parallel and analogous changes in forest history in the Alps and in regions far afield were indeed synchronous, but Welten's new chronology goes far to set such doubts at rest. His date of 5400 B.C. for the sudden extension of the mixed oak forest in *Faulenseemoos* corresponds closely with that given by Fromm for the equivalent vegetational change in Ängermannland. Confirmation of Welten's own chronological series comes from such results as the estimated age of the end of the Neolithic period

at 1800 B.C., a close agreement with archaeological estimates.

From the relative and absolute amounts of the lake chalk, organic mud and mineral matter, Welten is able to deduce climatic conditions, as also from the vegetational changes recorded by the pollen analyses. The regional vegetational history begins with the early dwarf-willow stages when the soil was open to erosion; the middle dwarf-willow - grass stages with closed ground cover and abundant *Helianthemum alpestre*; the third willow stage with extension of the dwarf-birch and entry of the tree birches. Continued climatic improvement then led to an explosive but temporary expansion of the sea-buckthorn (*Hippophae rhamnoides*) in conditions of slight competition, and then to successive phases of dominance by *Betula pubescens* and *B. verrucosa*. About 6150 B.C. a climatic retrogression broke the trend of general amelioration, but thereafter the open pine woods were rapidly succeeded by hazel scrub, and afterwards by mixed oak forest. About 3200 B.C. beech became dominant, and thereafter persisted, in varying relation to the spruce and mixed oak forest, as an important forest component to the present day. Early human activity is reflected in the diagrams not only by changes in the pollen frequency, but by the appearance of cereal pollen, by increase in mineral deposition in the lake, and by the pollen of such introduced trees as the walnut. These elaborate and exactly dated diagrams will be of the utmost value to the study of quaternary history in central and southern Europe, and the work as a whole deserves our own attention and emulation.

Such studies as this show the manifold indexes by which the deposits of former lakes may be made to yield the secrets of their history, and of the vegetational changes which they and the surrounding areas have suffered through the long period since the Ice Age. Apart from its own great intrinsic interest, such knowledge affects biological and climatic issues of great and general importance, and constitutes a background essential to our attempts to understand the meaning of present vegetational types and present vegetational processes of lake biology. It is very much in the interest of British biology that means should be found to pursue such studies as these in our own lake basins, where at least equally rich rewards may be expected. Let us appoint and train these archivists.

H. GODWIN.

<sup>1</sup> Pollenanalytische, stratigraphische und geochronologische Untersuchungen aus dem Faulenseemoos bei Spiez. Von Max Welten. (Veröffentlichungen des Geobotanischen Institutes Rübel in Zürich.) Heft 21. Pp. 201. (Bern: Hans Huber, 1944.) 12.50 Schw. francs.

## OBITUARIES

Dr. Alexander Sand, F.R.S.

IN the completely unforeseen death of Alexander Sand at the age of forty-three, comparative physiology suffered a very severe loss. Not only was his later work distinguished in a remarkable degree, but so much more of the same calibre might have been expected from him in the next twenty years.

Sand's early work dealt with changes in electrical resistance accompanying the death of cells, and with the relation of combined nitrogen to the physiological activity of *Azotobacter*. After his appointment as lecturer in zoology at Capetown under Hogben, he undertook a series of experimental studies dealing

with invertebrates, the first of which described the relation of electrolytes to the cardiac rhythm of *Jasus* and *Octopus*, the others the respiratory exchange of certain arthropods (a crab and a scorpion) and of a marine worm (*Bispira*). This work was accompanied by determinations which were made by Sand of the hydrogen-ion concentration and oxygen-content of samples of sea water, in connexion with studies undertaken by colleagues. His next work concerned chameleons. After a peculiarly neat and illuminating paper [describing adequately, for the first time, the mechanism of the projection of the chameleon's tongue (1933), he published another important paper describing the bionomics and physiology of the pigmentary activity of this animal. These papers were followed by a contribution to *Biological Reviews* on the comparative physiology of colour-response in reptiles and fishes.

After Sand's return from Cape Town to England he was appointed physiologist to the Marine Biological Laboratory at Plymouth, and thenceforward his interests were devoted to experiments on fishes, dealing primarily with certain of their sense organs. He published in 1936, in collaboration with James Gray, papers on the locomotory rhythm and spinal reflexes of the dogfish. After a preparatory period, during which he mastered the complex and delicate apparatus required, Sand attained the height of his ability and began his final work on the sense organs. This work, carried out partly in collaboration with Otto Löwenstein, involved a series of precise and beautiful experiments, and resulted in a most marked and definite advance in our knowledge not only of the labyrinth of fishes, but also of the lateral sense organs and of the peculiar ampullæ of Lorenzini. It is this last body of work for which Sand will be longest remembered, and which entitles him to rank high among British comparative physiologists. He was elected to the Royal Society in 1944. Two of his collaborators, Gray and Löwenstein, have already been mentioned; but during his whole career Sand also published joint papers with Lancelot Hogben, Enid Charles and others.

One of Sand's outstanding characteristics, the precision of his use of experimental apparatus, came out not only in his research work but also in his teaching. During his years at Cape Town he conducted a class in comparative physiology which was distinguished by its finished and flawless demonstrations. Sand served in the Royal Navy during the Second World War, and died on July 11, 1945. His death has come as a great shock to his many friends.

T. A. STEPHENSON.

### Prof. Ludwik Wertenstein

THE tragic death of Prof. Ludwik Wertenstein, who was killed in January during the battle for Budapest, deprives Poland of one of its leading men of science, and represents a grievous loss to physicists generally, among whom he had many personal friends.

Born in Warsaw in 1885, Wertenstein received his early education there and entered the University, which he had, however, to leave in 1906, after one year of study, because of taking part in the students' protest strike against the policy of the Tzarist regime. He went to Paris, where he entered the Sorbonne and began to work in Madame Curie's laboratory. His first scientific work was published in 1909 and

was soon followed by a series of papers dealing mainly with the properties of recoil atoms of radioactive elements, a subject which, with his usual thoroughness, he pursued and studied for many years. He measured the range, ionization and charge of recoil atoms, and some conclusions of these experiments were recently confirmed in the study of the ionizing properties of fission fragments.

In 1913, the Scientific Society of Warsaw founded, under the auspices of Madame Curie, the Radiological Laboratory, where research work on radioactivity was to be centred. Madame Curie sent her two most outstanding pupils, Danysz and Wertenstein, to Warsaw to direct the work there. After the death of Danysz in 1914, Wertenstein became director of the Laboratory, and he remained there until its destruction in 1939. In 1919 he was appointed to the chair of radioactivity at the Free University of Poland, where he later founded the Laboratory of Atomic Physics. Except for the period 1925-26, which he spent at the Cavendish Laboratory under the late Lord Rutherford, all his scientific work was done in these two laboratories. Despite the constant difficulties and limitations due to lack of funds, he managed to create a centre of research which gained a high reputation abroad, and to form a school from which came a number of young men of science of standing.

Most of Wertenstein's scientific work was in the field of radioactivity; he made a detailed study of the properties of radon, found new methods for its purification, investigated its condensation properties, measured its vapour pressure and ionization potential, and determined the volume of one curie, an important quantity in radioactivity. But his interests embraced many other branches of physics, and among the large number of papers he published are some on such divergent subjects as vacuum technique, photochemical law and isotope separation. In recent years, he concentrated mainly on nuclear physics, in particular on problems of inelastic scattering of neutrons, photo-nuclear effects and fission. His last paper, on gaseous fission products, published in *Nature* of December 29, 1939, was sent out of Poland when it was already occupied by the Germans.

Apart from pure scientific work, Wertenstein took an active part in the organization and popularization of science in Poland. He was a member of the Academy of Technical Sciences, and president of the Physical Society of Warsaw. His agile, penetrating and critical mind, swift reasoning, and almost uncanny facility for operating with figures mentally, made every discussion in the Physical Society a lively and exciting event. His was a most remarkable and versatile mind; apart from being a brilliant experimenter and highly skilled in various techniques, he was an excellent theoretician and had a deep knowledge of mathematics. He spoke fluently many languages, was a classical scholar and had great literary talent. His quickness and wit, combined with a deep sense of humour, made him most popular at all scientific and social gatherings. An excellent speaker, he had a particular gift of presenting difficult problems in a simple manner, and his public lectures—masterpieces in language and composition—always attracted large audiences. His articles in various magazines and Sunday papers contributed a great deal to the popularization of science in Poland. He translated a number of books into Polish, the last being Madame Curie's "Radioactivité"; the translation of this was just finished when war broke out,



and it achieved the unique honour of being published by the underground movement; it was the main scientific book used by the students of Poland's Underground University, in which Prof. Wertenstein took an active part. Little is yet known about his fate during the war years; but he was hunted by the Germans and had to hide in various parts of the country. Finally he managed to escape to Hungary, and there, on the eve of the liberation of Budapest by the Red Army, he was killed by a shell fragment during the battle for that city.

I cannot end this note without a tribute to Prof. Wertenstein's character and personality. He possessed such virtues as made him an outstanding man even without his scientific achievements. He was exceptionally kind, generous, friendly and utterly unselfish. Everyone who knew him was charmed and attracted by his cordiality, cheerfulness and modesty. But we, his students, who worked with him closely, could most fully appreciate the integrity of his character. He was not merely a teacher but also a friend and counsellor; he cared not only for our intellectual needs but also for our general welfare, and would not spare any efforts to meet any of our difficulties. He will always remain in our memory a symbol of the ideal man of science, a perfect blend of brilliance and kindness, erudition and good humour, enthusiasm for Nature and love of humanity.

J. ROTBLAT.

#### Prof. Walter Makower, O.B.E.

THE death of Prof. W. Makower at the age of sixty-five occurred on July 7. Makower graduated from University College, London, where he took honours in chemistry; but going to Cambridge as a research student under Thomson effected his transformation into a physicist, and his M.A. was for a thesis on the diffusion properties of radium emanation (radon). From the Cavendish Laboratory he went to Manchester as a John Harling Research Fellow under the directorship of Schuster. On the latter's retirement in 1906, Makower became lecturer on the staff of Rutherford, whose arrival in Manchester gave a great impetus to radioactive studies. Over a period of years Makower did experimental work in this subject; he showed that radium *A*, *B* and *C* all had different temperatures of volatilization and that the behaviour of the active deposit depended largely on the pressure conditions within the vessel. Later on he collaborated with Prof. S. Russ on radioactive recoil, with Fajans on the beta-rays from radium *B* and with Moseley on the gamma radiation from the same substance; with Geiger he wrote a timely book on radioactive measurements. He had previously written one of the earliest books on radioactivity entitled "The Radioactive Substances".

Outside the precincts of the Physics Department, Makower spent a good deal of his leisure at the kite-flying station installed high up on the moors above Glossop in Derbyshire. He escaped injury when the kite he was flying was struck, setting on fire the hut in which the winding machinery was installed.

The War of 1914-18 found him serving first as a lieutenant R.N.V.R. and then as a captain R.F.C.; both positions he filled in a scientific capacity.

After sixteen years service in the Physics Department at Manchester, Makower became attached to the research laboratory of the Dunlop Rubber Company, but he was glad to return to professional life when appointed in 1925 to the post of professor of science at the Royal Military Academy, Woolwich. This post he

held until 1938 when he resigned; he was awarded the O.B.E. in 1934.

During the years of retirement he did valuable work for the Institute of Physics.

Walter Makower came of a cultured family, all the members being musical; he was no mean performer on the 'cello. Those who knew him intimately valued him most for his sense of humour and his integrity of mind. He married Dorothy Lois Drey who, with their two daughters and a son, survives him.

#### Miss E. R. Saunders

THE obituaries of Miss E. R. Saunders in *Nature* of August 18, 1945, while describing her morphological and educational work, do not refer to her contributions to genetics. These were, however, of the first importance. In 1897 she began experimental plant breeding at Cambridge in collaboration with Bateson, and the results were presented to the Evolution Committee of the Royal Society in 1901. Meanwhile Mendel's work had been rediscovered in 1900. By 1901 she had established the existence of Mendelian inheritance in *Lycinis*, *Datura* and *Matthiola*. It is clear that she and Bateson had independently rediscovered some at least of Mendel's laws before his work was known to them. She must in fact be regarded as the 'mother' of British plant genetics.

Her later genetical research was mainly on *Matthiola incana*. Here she successfully analysed what was then the most complicated known case of genic interaction. Any of four independent recessive genes may render a plant of this normally hoary species glabrous. Two of them also make it white. She also described, in connexion with doubleness, what, in modern terminology, is the first case of balanced lethals, and the second case of linkage. Up to her death she continued to display a lively interest in all branches of genetics, and was treasurer of the Genetical Society. To all geneticists her death was a loss; to many a personal loss.

J. B. S. HALDANE.

#### Dr. G. V. Buchanan

DR. GWYNNETH VAUGHAN BUCHANAN, senior lecturer in zoology at the University of Melbourne, died towards the end of June 1945. Dr. Buchanan was born in Sydney in November 1886, and was educated at Toorak College and the University of Melbourne. For a time she acted as professor of zoology in the University of Western Australia before she returned to her old university as senior lecturer under Sir Baldwin Spencer. To English zoologists she is perhaps best known for her outstanding work on the development of the marsupials, undertaken in conjunction with Dr. Elizabeth Frazer at University College, London, in 1918. In Australia, the great influence for good that she exercised on the many students to whom she was so much more than a mere university teacher will long be remembered. It was largely owing to her influence and enthusiasm that the McCoy Society for Field Investigation and Research came into being and became such an outstanding success. After some months of ill-health, bravely borne, she retired from active teaching in February of this year, but until the last she continued her enormous correspondence with old students scattered, by the War, to distant parts of the world.

F. WOOD JONES.

## NEWS and VIEWS

## Chemistry at Leeds: Retirement of Prof. W. R. Whytlaw-Gray, O.B.E., F.R.S.

PROF. ROBERT W. WHYTLAW-GRAY is retiring from the chair of chemistry in the University of Leeds at the end of this month after twenty-two years service. During his administration, the Department of Chemistry has undergone many changes, including its entry into a new building, in the design and equipment of which he took a leading part, and which has proved to be almost ideally arranged for both teaching and research. Throughout his academic life at University College, London, in Bonn, at Eton or in Leeds, Prof. Whytlaw-Gray has devoted himself wholeheartedly to research work, whether in pursuit of exact knowledge for its own sake or (for the second time) in the application of his special experience to his country's war-time problems. Before going to Leeds, he had developed a technique for the examination of smokes with the ultra-microscope which led to the determination of particle size and number, and to the discovery that these aerial systems, unlike the more familiar hydrosols, are unstable and undergoing continuous coagulation. At Leeds, with the help of collaborators, notably Dr. Colvin, Mr. H. S. Patterson and Dr. W. Cawood, the coagulation process was fully explored, new methods developed both for counting the particles when suspended and after sedimentation, and, in a series of papers, the kinetics of smoke coagulation established on a sound quantitative basis. The results of these investigations and their bearing on aerial systems in general were summarized in the Liversidge Lecture delivered before the Chemical Society in 1935 and in a book entitled "Smokes" written in collaboration with H. S. Patterson.

Prof. Whytlaw-Gray has always been much interested in the determination of the atomic and molecular weights of gases by physico-chemical methods, and many investigations in this field have been made in the Leeds laboratories. Previous experience in determining the density of radon by means of a Steele and Grant microbalance led him to the development of a buoyancy microbalance capable of high accuracy in which constancy of zero was ensured by a torsion fibre suspension. With this instrument the limiting densities of xenon, carbon monoxide, carbon dioxide, ethylene, carbon tetrafluoride, methyl fluoride, silane, nitrous oxide and hydrogen sulphide were determined, and values for the atomic weights of carbon, fluorine, nitrogen, sulphur and silicon obtained which are independent of stoichiometric relationships. This work with gases containing carbon first brought to light an error in the atomic weight of carbon which, prior to 1933, was accepted by the International Committee as 12.00. The mean value found at Leeds was 12.011, which has been amply confirmed since by modern stoichiometric determinations and also by mass-spectrographic evidence. In these and other ways, Whytlaw-Gray has built up an influential research school at Leeds, and well and truly carried on the tradition of his distinguished teacher, Ramsay. He has never rested on his achievements, although these have received universal recognition. Ripening experience has, in his case, resulted rather in more devotion to experimental work and to its stimulation in others. It is a source of great satisfaction to his colleagues that

he is to continue his investigations in the Department of Inorganic and Physical Chemistry at Leeds.

## Prof. M. G. Evans and Prof. E. G. Cox

WITH the retirement of Prof. Whytlaw-Gray, the Council has decided to unite the hitherto separate Departments of Inorganic and Physical Chemistry. The combined Department will have two professors, of whom Prof. M. G. Evans, professor of physical chemistry in the University since 1939 (see *Nature*, July 1, 1939, p. 15), will be the senior. Dr. E. G. Cox, reader in chemical crystallography in the University of Birmingham, has been appointed to the second chair in the Department. For several years Dr. Cox has been on leave of absence to undertake highly specialized and secret work in the Government service, and has had charge of a laboratory. Latterly he held the rank of lieutenant-colonel on the staff of the B.L.A. in Europe. Dr. Cox is well known as one of the ablest experimenters in X-ray crystallography. His researches in the carbohydrate field, and also in connexion with co-ordination compounds, have won for him a high place as an investigator in structural chemistry. Graduating with first-class honours in the University of Bristol some twenty years ago, he proceeded to the Davy Faraday Laboratory at the Royal Institution and became a pupil of Sir William Bragg. From there he was appointed to a lectureship in physical chemistry in the University of Birmingham, and has been associated with Prof. W. N. Haworth in constitutional work on sugars and polysaccharides. One of his most notable researches was on the structure of vitamin C.

## Penicillin Production in Great Britain

ON September 20, Glaxo Laboratories, Ltd., Greenford, Middlesex, gave a demonstration of the preparation of penicillin and showed the factory operation of freeze-drying and other processes through which the finished product goes; Sir Cecil Weir, director-general of equipment and stores, Ministry of Supply, was present. Sir Cecil said that during the War when key installations were open to enemy attack, it would have been wrong to give information about the location of factories concerned; but now it is possible to disclose that the production of penicillin is under way, or about to commence, in twelve factories in Britain, operated by eight firms well known in the pharmaceutical field or in fermentation processes. Britain will soon have in operation the largest penicillin production unit in the world at Speke, and one of the largest at Barnard Castle; the latter is to be run by Glaxo Laboratories, and will make four for which the firm is responsible.

As soon as it became evident in 1942 that factory production of penicillin was feasible, the Ministry of Supply brought together potential manufacturers and scientific men, and the present results are due to the team-work thus initiated. As British resources in building and operational labour, as well as scientific and technical staff, were fully extended, it was not expected that progress would be so rapid in Britain as in the United States, but close touch was maintained on the subject between the two countries. Britain has shared with the United States for military purposes the greater production which that country was able to obtain during the War; but it will not be long before Britain is producing penicillin on a comparable basis. The history of penicillin pro-

duction during the War has much in common with that of the atomic bomb; in both cases production was undertaken in the United States on account of the greater facilities available and the freedom from bombing. Sir Cecil also referred to recent references in the Press to the possibility that penicillin may become infected in the course of manufacture. This danger always exists in fermentation processes, particularly in the early development of a new factory, but, as was to be seen at the Glaxo Laboratories, the manufacturers take every precaution to maintain sterility; and there is no ground for any suggestion that a great deal of penicillin is unfit for use.

### Folk-Lore of Toothache

In a recent article on this subject (*Brit. Dent. J.*, 78, 226 and 257; 1945), forming the quinquennial Wallis Lecture and read before a conjoint meeting of the Sections of Odontology and History of Medicine of the Royal Society of Medicine, Dr. J. D. Rolleston said that the abundance of dental folk-lore was shown by the numerous books and articles, of which the best known in alphabetical order were those of Baldinger, Bremner, Guerini, Haber, Kahn, Kanner, Lindsay, Lufkin, Sudhoff, Taylor, Townend and Weinberger. Owing to the extensive character of dental folk-lore, Dr. Rolleston confined himself to its most prominent aspect, toothache, and no reference was made to the superstitions of normal dentition, the discoloration and mutilation of the teeth in savage races, the legend of the Golden Tooth, the toothpick and the toothbrush and the various aspects of dental surgery, apart from a brief allusion to filling and extraction.

There are numerous examples of the transfer of toothache to other persons, as can be seen from Sir James Frazer's volume of the "Golden Bough" entitled "The Scapegoat". Hydrotherapy for toothache was instanced by the large number of wells believed to cure toothache, especially in Scotland, the Palatinate and Upper Austria. Charms against toothache date back for many centuries, the earliest of the kind having been found in the Babylonian legends of 4000 B.C. During the Middle Ages, charms, which are the most popular of toothache remedies, were sometimes spoken, but were more frequently inscribed on paper, parchment, wood or stone, and were hung round the patient's neck or loins. Professional charmers have existed until modern times. Patron saints play an important part in the folk-lore of toothache, as they do in that of other diseases. The chief patron saint of dentistry is St. Apollinaria, who died a martyr in A.D. 249, whose memory is kept alive by relics and pilgrimages in various European cities and in Britain. Besides St. Apollinaria there are more than twenty saints supposed to relieve or cure toothache.

### The Night Sky in October

New moon occurs on Oct. 6d. 05h. 22m., U.T., and full moon on Oct. 21d. 05h. 32m. The following conjunctions with the moon take place: Oct. 3d. 12h., Venus  $4^{\circ}$  S.; Oct. 27d. 05h., Mars  $0.8^{\circ}$  S.; Oct. 27d. 05h., Saturn  $2^{\circ}$  S. In addition to these conjunctions with the moon, the following conjunctions take place: Mars in conjunction with Saturn on Oct. 26d. 07h.; Mars  $1.4^{\circ}$  N.; Venus in conjunction with Jupiter on Oct. 30d. 08h., Venus  $0.5^{\circ}$  N. No occultations of stars brighter than magnitude 6 take place during the month. Mercury is in superior conjunction with the sun on Oct. 2 and is unfavour-

ably placed for observation during the month. Venus is a morning star, rising at 3h. 12m., 3h. 56m., and 4h. 45m., at the beginning, middle and end of the month respectively. Mars, in the constellation of Gemini, rises at 22h. 08m. on Oct. 1 and at 21h. 15m. on Oct. 31. Jupiter, in conjunction with the sun on Oct. 1, rises an hour before the sun at the middle of the month and a little more than two hours before the sun at the end of the month, and can be seen in the morning hours. Saturn, in the constellation of Gemini, rises at 23h. 07m. on Oct. 1 and at 21h. 15m. on Oct. 31. The Orionid meteors are due about the third week in October, but moonlight will partly interfere with observations of this shower.

### Announcements

MESSRS. Coventry Gauge and Tool Co., Ltd., Taylor, Taylor and Hobson, Ltd., and E. R. Watts and Son, Ltd., have agreed to co-operate in the development and distribution of precision engineering and optical equipment. They will pool their technical and manufacturing resources for the development of new instruments, while the sales and service departments will handle the products of all three firms.

It is announced that a catalogue of all the medical films in Great Britain is now being prepared by the Royal Society of Medicine in co-operation with the Scientific Film Association. It would be appreciated if any persons having films of medical or paramedical interest, who have not already been asked for details, would communicate with the Film Cataloguer, Royal Society of Medicine, 1 Wimpole Street, W.1. By so doing they would not commit themselves or their films, but would enable the catalogue to be complete.

THE National Cancer Institute at Bethesda, Maryland, has undertaken to compile and publish all the data available relative to cancer therapy. All types of therapy except surgery and irradiation will be covered. Negative and positive results of the treatment of spontaneous, transplanted and induced experimental tumours, and of clinical cases, will be included. The data will be classified and tabulated in a simple manner similar to that in Hartwell's "Survey of Compounds Which Have Been Tested for Carcinogenic Activity" (National Cancer Institute, 1941). Reprints of published work in this field or any unpublished results which may be used should be sent to Prof. Helen M. Dyer, National Cancer Institute, Bethesda 14, Maryland, U.S.A.

THE Electrical Association for Women is marking its twenty-first anniversary by an exhibition, arranged by the British Electrical Development Association, at the Dorland Hall, Lower Regent Street, London, S.W.1, during October 11-25. The exhibition will be opened by the Duchess of Kent, and at the following luncheon Sir Stafford Cripps will speak. On October 12 there will be addresses by Sir Robert Watson-Watt, Dr. Kathleen Lonsdale and Sir Harry Railing. The Women's Engineering Society, the body from which the Electrical Association for Women arose, is holding its annual conference during October 12-13; Miss M. M. Partridge will give the presidential address on "The Next Twenty-one Years".

ERRATUM. In *Nature* of September 22, p. 371, col. 1, line 23, for "the production of gas from sulphur" read "the production of gas almost free from sulphur".

LETTERS TO THE EDITORS

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

A New Test for 2 x 2 Tables

UNDER this heading, G. A. Barnard<sup>1</sup> puts forward a test which, in language adopted from Neyman and Pearson, "is more powerful than Fisher's". This means in practice that the test advocated passes as significant certain classes of experimental result which, by the test I had put forward<sup>2</sup>, would have been judged insignificant; and that, as judged by Barnard's method, my test is thought to be too stringent. However one may choose to express it, the cause of the difference in these calculations is worth elucidating, and, in taking the view he does, Barnard is following the very distinguished precedent of Prof. E. B. Wilson, whose similar proposal a few years ago<sup>3</sup> led to some clarification of the issue<sup>4,5,6</sup>.

In the treatment of the problem for which I am responsible, all possible fourfold tables are classified according to the marginal distributions they exhibit. Thus in the case considered by Barnard in which, using three experimental and three control animals, the experimental animals all die and the control animals all survive, the two marginal distributions are both specified by the partition (3<sup>2</sup>). Subject to this restriction, only four different experimental results are possible, symbolized by

$$\begin{array}{c|c} 3 & 0 \\ \hline 0 & 3 \end{array} \quad \begin{array}{c|c} 2 & 1 \\ \hline 1 & 2 \end{array} \quad \begin{array}{c|c} 1 & 2 \\ \hline 2 & 1 \end{array} \quad \begin{array}{c|c} 0 & 3 \\ \hline 3 & 0 \end{array};$$

and I have demonstrated that, *whatever may be the probability of survival*, if it is the same for both lots, the probabilities of these four possible outcomes are in the ratio 1 : 9 : 9 : 1; or, in other words, the probability of obtaining the most successful outcome by chance is always 1 in 20. For any other marginal distributions a similar series can be obtained, but with these even the most favourable outcome has so high a chance probability that in no case could it be judged significant. It is my view that the existence of these less informative possibilities should not affect our judgment of significance based on the series actually observed.

It may, however, be demonstrated that with repeated sampling, using always three experimental and three control animals having the same probability of death, such outcomes will often occur. If it were legitimate to judge the level of significance from the proportion of significant judgments in the whole series of 'repeated sampling from the same population', these cases would be brought in to inflate the denominator of the fraction. The least possible frequency of these other series occurs when the chance of death is  $\frac{1}{2}$  for both groups, and, in the aggregate, they will then occur 44 times to 20 occurrences of the series observed. Thus Barnard's argument leads to the conclusion that the acceptance of the result as significant is at the significance level 1/64 rather than 1/20; or, more properly, that it has some unknown value not greater than 1 in 64.

In my view the notion of defining the level of significance by 'repeated sampling of the same population' is misleading in the theory of small samples just because it allows of the uncritical inclusion in the denominator of material irrelevant to a critical judgment of what has been observed. In 2 of the 64 cases enumerated above, all animals die or all survive. The fact that such an unhelpful out-

come as these might occur, or must occur with a certain probability, is surely no reason for enhancing our judgment of significance in cases where it has not occurred; any more than the possibility that a breeding experiment might have yielded too few offspring to allow one to draw any significant conclusion should not enhance our judgment of significance whenever there are enough offspring for the significance of any supposed effect to be worth discussing.

Of course, the notion of repeated sampling from the same population is usually taken to imply that the total size of the sample is fixed. The total size does not, however, always suffice to specify the type of sample which has been obtained, and it is only the sampling distribution of samples of the same type that can supply a rational test of significance.

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Department of Genetics,  
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Aug. 13.

- <sup>1</sup> Barnard, G. A., *Nature*, 156, 177 (1945).
- <sup>2</sup> Fisher, R. A., "Statistical Methods for Research Workers" (Edinburgh: Oliver and Boyd, 1944), Section 21.02.
- <sup>3</sup> Wilson, E. B., *Science*, 93, 557 (1941).
- <sup>4</sup> Fisher, R. A., *Science*, 94, 210 (1941).
- <sup>5</sup> Wilson, E. B., *Proc. U.S. Nat. Acad. Sci.*, 28, 94 (1942).
- <sup>6</sup> Wilson, E. B., and Worcester, Jane, *Proc. U.S. Nat. Acad. Sci.*, 28, 378 (1942).

A Classical Theory of Electromagnetism and Gravitation

ATTEMPTS to obtain a unified theory of gravitational and electromagnetic phenomena<sup>1</sup> have assumed the form of generalizing the equations of general relativity theory, so that they incorporate terms which may be identified with electromagnetic potentials and charge and current distributions. At the moment it seems that these attempts will not lead to an explanation of such quantum theoretical results as the indeterminacy principle, and their very complexity makes it difficult to see how they will yield a hint as to necessary modifications of the equations of quantum theory required to overcome the difficulties inherent in its present form. In any event, such a synthesis of gravitational and electromagnetic phenomena in quantum theory is generally regarded as secondary in importance, since gravitational forces on elementary particles are extremely small.

It seems of interest, however, to return to the classical theory and look for a simple set of equations which give simultaneously a relativistically covariant theory of gravitational and electromagnetic phenomena. For regions of space occupied only by charge and current distributions, the Maxwell-Lorentz equations

$$\begin{aligned} \frac{\partial f_{\nu\sigma}}{\partial x_\mu} + \frac{\partial f_{\sigma\mu}}{\partial x_\nu} + \frac{\partial f_{\mu\nu}}{\partial x_\sigma} &= 0, \\ \frac{\partial f_{\mu\nu}}{\partial x_\nu} &= \frac{4\pi}{c} i_\mu, \quad k_\mu = \frac{1}{c} f_{\mu\nu} i_\nu \quad \dots \quad (1) \end{aligned}$$

give a very satisfactory system of Lorentz covariant equations for the determination of either the electromagnetic field produced by a given charge distribution or the behaviour of a charged body in such a field. The equations are simplified if the Lorentz condition

$$\frac{\partial A_\nu}{\partial x_\nu} = 0 \quad \dots \quad (2)$$

be applied, where

$$f_{\mu\nu} = \frac{\partial A_\nu}{\partial x_\mu} - \frac{\partial A_\mu}{\partial x_\nu}$$

In these equations gravitational forces do not appear, and it is usual in classical theory to treat problems involving gravitational potentials separately. The original theory of Kaluza is based on the introduction of an extra dimension, of no physical significance. We therefore consider the above equations (1) and (2) when we allow the suffixes to assume the values 1 up to 5. Writing  $A_5 = -\Omega$ ,  $i_5 = c\sigma_0$ ,  $x_5 = R$ , we are led to the equations

$$\nabla \cdot \mathbf{A} + \frac{\dot{\phi}}{c} - \frac{\partial \Omega}{\partial R} = 0 \quad (3)$$

$$\left( \nabla^2 - \frac{1}{c^2} \frac{\partial^2}{\partial t^2} + \frac{\partial^2}{\partial R^2} \right) \frac{\mathbf{A}}{\Omega} = -4\pi \begin{matrix} i/c \\ -\rho \\ \sigma_0 \end{matrix} \quad (4)$$

$$\mathbf{k} = \mathbf{E}\rho + \frac{1}{c} (\mathbf{i} \times \mathbf{H}) - \sigma_0 \nabla \Omega - \sigma_0 \frac{\partial \mathbf{A}}{\partial R} \quad (5)$$

$$cW = \mathbf{i} \cdot \mathbf{E} + \sigma_0 \dot{\Omega} - c\sigma_0 \frac{\partial \phi}{\partial R}$$

$$\nabla \cdot \mathbf{i} + \dot{\rho} = -c \frac{\partial \sigma_0}{\partial R} \quad (6)$$

Equations (5) suggest that  $\sigma_0$  may be identified with the rest density, and  $\Omega$  with the gravitational potential. Since  $\sigma_0$  is invariant for rotations of the axes  $x_1 \dots x_4$ , the result arises that gravitational force per unit volume is exerted only on the rest-mass density, and not on the increased density arising from a possible velocity of the matter relative to the observer. If we set  $\frac{\partial}{\partial R} \equiv 0$ , the equations are

applicable to flat space-time, and gravitational waves are seen from (4) to be propagated with the velocity of light. In agreement with the generalized unified theories, equation (6) shows that charge is conserved only for flat space-time.

It does not seem reasonable that the extra dimension  $R$  should be singled out for special attention, and in general the gauge is shown from (3) to be simply connected with the rate of change of the gravitational potential in this extra direction. We may attach physical significance to  $R$  if it is noted that the radius of curvature of space-time at a particular point is different for observers accelerated with respect to each other. We therefore postulate that to an observer  $S_0$  falling freely under the influence of the local gravitational field, space-time in his immediate neighbourhood appears flat, and we may set  $\frac{\partial}{\partial R} \equiv 0$ . To an observer  $S$  accelerated with

respect to  $S_0$ , the same space appears to have a finite principal radius of curvature  $R$ . From these assumptions a simple generalized theory of transformations may be developed to compare the observations of observers accelerated with respect to each other, in the same way that the theory of Lorentz transformations yields the results of the special theory of relativity.

Details of the theory will be published later.

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May 24.

### Cosmic Rays and Kinematical Relativity

I ADMIT (indeed, I insist on) Prof. Haldane's claim<sup>1</sup> that kinematical relativity would be justified in substituting another "equally valid" cause of the red-shift for relative motion; my point is that it has not done so. In my letter<sup>2</sup>, I named all the causes (I do not insist on this terminology if Prof. Haldane can think of a simpler and equally clear one) I could think of, and Prof. Milne chose<sup>3</sup> relative motion. It was then that I repeated the objection Prof. Haldane has quoted. If he prefers a different choice from Prof. Milne's, I will repeat the objection to that. It is, however, futile to run from one untenable explanation to another, like a squirrel in a cage.

The basic objection to Prof. Milne's theory is that it allows the distance between Prof. Haldane's nose and the lamp-post to remain constant at what it was, say, one minute before impact, in spite of the fact that his nose is broken. It will concentrate the whole problem into a single point if Prof. Haldane will state how he accounts for his disfigurement, and how he dates subsequent events, on the time-scale which keeps the lamp-post a constant distance away.

I am not sanguine of the possibility of convincing Prof. Milne by a *reductio ad absurdum*. Deductions concerning stellar evolution are apt to become 'verifiable' in a few billion years time. In the meantime, I believe I have reduced the fundamental principle, not merely a particular application, to absurdity by the argument now under discussion; but Milne refuses to regard this as a blemish because I have not indicated a flaw in his voluminous mathematics<sup>4</sup>. He will not recognize that an absurdity can follow from false premises even though (indeed, because) the connecting mathematical argument is faultless. Hence I do not expect that any difficulty connected with what is presumed to have happened a thousand million years ago will convince him that he is following a will-o'-the-wisp.

As regards cosmic rays, Milne's theory of this phenomenon<sup>4</sup> requires space to be filled with particles moving faster than light; but he gets around this by saying that such particles would be unobservable. I pointed out some time ago<sup>5</sup> that such particles, if they existed, must be constantly hitting stars, and since their momentum would be infinite the consequences would not be unobservable. No reply has been made to this. So much for the hopes of a test of the theory arising from "agreement or disagreement with fact of calculations concerning cosmic rays".

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<sup>1</sup> *Nature*, 156, 266 (1945).  
<sup>2</sup> *Nature*, 155, 511 (1945).  
<sup>3</sup> *Nature*, 155, 512 (1945).

<sup>4</sup> "Relativity, Gravitation and World Structure", p. 234.  
<sup>5</sup> "Through Science to Philosophy" (1937), p. 198.

### Interaction of Aluminium Halides with the Xylenes

RECENTLY<sup>1</sup>, it has been suggested that the study of equilibria between the aromatic hydrocarbons<sup>2</sup> in the presence of aluminium halides might be complicated by the formation of stable complexes between the aluminium halide and some of the hydrocarbons. If, as has been shown<sup>1</sup>, the heat of complex formation varies considerably with different hydrocarbons, then the composition of the equilibrium

<sup>1</sup> Weyl, *Ann. Phys.*, 59, 101 (1919). Kaluza, *Sitz. Preuss. Akad. Wiss.*, 966 (1921). Pauli, *Ann. Phys.*, 13, 1305, 337 (1933). Einstein and Mayer, *Berl. Ber.*, 541 (1931); 130 (1932).

mixture of free hydrocarbons will be different from the composition of the mixture of hydrocarbons in the complex. This may lead to uncertainty in the equilibrium concentrations of hydrocarbons, if, as in much of the experimental work described in the literature<sup>2,3</sup>, only the total hydrocarbon, including both the free hydrocarbon and that obtained by decomposing the complex, is analysed, since this may result in equilibria which appear to vary with the ratio of aluminium halide to hydrocarbon. Some recent exploratory experiments of ours are of interest in this connexion.

At equilibrium, the system aluminium halide and xylene separates into two phases: (A) a supernatant, pale brown, mobile layer which contains only a trace of aluminium halide; (B) a more dense, very dark brown, viscous layer which contains most of the aluminium halide. This latter layer can be separated, as has been suggested by Norris and Rubenstein<sup>4</sup>, into two fractions: (B1) a colourless hydrocarbon layer containing no aluminium halide, which is separated from the non-volatile fraction B2 by vacuum distillation at 20° C.; and (B2) a very dark, very viscous residue which, when carefully decomposed with water at 0° C., gives an almost colourless hydrocarbon mixture.

In the present work, these three fractions (A, B1, B2) were distilled in vacuum at 20° C., washed with dilute caustic soda and then water, and dried with calcium chloride. The compositions of the fractions were determined from their ultra-violet spectra, since aromatic hydrocarbons have characteristic spectra in this region. The absorption spectra of 0.5 per cent solutions by volume of these fractions in spectroscopically pure cyclohexane were photographed using an absorption path-length of 1.8 mm. The starting materials were either a *meta-para* xylene mixture (approximately 4:1) or an *ortho-meta* mixture (approximately 95 per cent *ortho*), and these were equilibrated at 20° C. and at 60° C. with aluminium chloride.

Inspection of all the photographs suggested: (1) Fraction B2 is always different from A and different from B1. (2) B1 is, in all cases, very nearly the same as, or possibly identical with, A. (3) B2, formed when starting with the *ortho-meta* mixture, is not the same as when the *meta-para* mixture is used. In the latter case, B2 is almost entirely pure *meta*-xylene. There is no evidence that B2 is in true thermodynamic equilibrium. (4) Starting with the *meta-para* mixture, true equilibrium appears to be reached in the fraction A, since no variation of the composition with time has been found. This is in general agreement with Pitzer and Scott<sup>2</sup>. (5) Starting with the *ortho-meta* mixture, fraction A does not appear to reach equilibrium although longer times were employed than in (4). This may be due to: (i) the reaction having further to go to reach equilibrium when the starting material is largely *ortho*; (ii) the complex formed from *ortho* is different from that from *meta* and may not be so active catalytically; (iii) side reactions may become important when starting with *ortho*; our analyses cannot exclude the presence of toluene after reaction, although benzene is certainly absent. (6) In the reaction starting with the *ortho-meta* mixture, aluminium bromide behaves qualitatively similarly to the chloride.

These results show that the system is very complicated, and, although much more work must be done before the system is completely understood, the following picture appears to be qualitatively correct.

At equilibrium, the system aluminium chloride and xylene forms two immiscible liquid phases, one of which is a very dilute solution of the aluminium chloride complex in the normal equilibrium hydrocarbon mixture, and the other is a mixture of the complex and the normal equilibrium hydrocarbon mixture. The composition of the hydrocarbon mixtures in the complex and in the free state is always different. Before a picture of aromatic equilibria can be completed, a detailed analysis of all possible separate phases is essential.

One of us (E. F. G. H.) wishes to thank the Director of Fuel Research for permission to publish this communication.

H. CAMPBELL.

E. F. G. HERINGTON.

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June 12.

<sup>1</sup> Campbell and Eley, *Nature*, **154**, 85 (1944).

<sup>2</sup> For example, Pitzer and Scott, *J. Amer. Chem. Soc.*, **65**, 803 (1943).

<sup>3</sup> Norris and Vaala, *J. Amer. Chem. Soc.*, **61**, 2131 (1939).

<sup>4</sup> Norris and Rubenstein, *J. Amer. Chem. Soc.*, **61**, 1163 (1939).

## A Sexual Reproduction Cycle of *Trypanosoma congolense* Broden

DURING the course of work on the destruction of trypanosomes by phagocytes in the blood of cattle, gamete forms of *Tryp. congolense* were observed in thick unfixed blood smears, both paired and unpaired.

This phenomenon, at first thought to be an appearance caused by staining with Giemsa of unfixed blood preparations, was studied, and developmental forms were found in Giemsa-stained smears and sections from the skin of infected cattle. *Tryp. congolense* was then stimulated to conjugate by addition to a drop of heavily infected mouse blood of a drop of hypotonic saline solution (0.3 per cent sodium chloride), and the actual conjugation was seen under the microscope. This technique, though possibly unsuitable for a morphological study of trypanosome forms, is convenient, since the process of conjugation can be studied with ease, owing to hæmolysis of most red blood cells. It is not, however, constantly seen, and it may be supposed that mature gametocytes are not always present.

In mouse blood, treated in this way, trypanosomes are not fatally injured, though the adult form is distended. Sexually mature forms quickly become micro- and macro-gametes and conjugate within ten minutes. The micro-gamete is 6–9  $\mu$  in length and the nucleus becomes posteriorly placed, with the rest of the body an attenuated filament; macrogametes are 13–19  $\mu$  in length, with the nucleus somewhat anteriorly placed, both nucleus and cytoplasm being intensely granular, except for a swollen area posteriorly which is clear and translucent. The posterior end of the microgamete enters the translucent posterior area of the macrogamete, and the microgamete is absorbed.

A motile zygote is formed, of trypanosome form, but tapering from the posterior end. Nuclear material is next concentrated centrally or posteriorly, and by contraction of other parts of the body an amorphous oocyst is formed. The oocyst nucleus may after sixty minutes have divided once. The zygote is about 20  $\mu$  in length, and oocyst about half this size.

Oocysts have been found in skin sections and in the lung of one calf, which was successively exposed

to cold at 4° C., in order to occlude the skin capillaries and drive the trypanosomes into the general circulation. Oocysts have also been studied in skin smears on supravital slides (neutral red) kept moist by addition of a drop of normal bovine serum. The oocyst appears to form sporoblasts, probably eight, which divide into innumerable sporozoites. The sporozoites break away from the oocyst body and swim actively away by a kind of rolling movement.

The fate of the sporozoite is uncertain. It is initially about 1-2  $\mu$  in diameter and its morphology has not been fully determined. It is probably leishmannioid, since larger forms have been seen of this type. It does not aggregate or develop in the tissues, though skin smears reveal developmental forms—leptomonad, crithidial and immature trypanosome. It is suspected that the macrophages are parasitized, since in skin, lymphatic gland and kidney sections, these cells have been found containing bodies, the larger of which are leishmannioid in appearance.

Trypanosomes treated with hypotonic saline in mouse blood react in three different ways and are plainly of three different forms as follows:

(1) Immature sexual or asexual. These become swollen by the saline, but show no other changes, though some may conjugate after forty-five minutes. (2) Mature sexual forms, which conjugate as described. (3) Infective (?) forms, which become changed into a variety of developmental types, usually associated with life in the tsetse fly, such as round forms, stumpy forms, elongated forms and so on.

These matters will shortly be described at greater length in a preliminary communication, and a full report published when all details have been studied.

R. N. T.-W.-FIENNES.

Veterinary Research Laboratory,  
P.O. Box 24, Entebbe,  
Uganda. June 23.

### Multiplication *in vitro* of Koch Bodies of *Theileria annulata*

THE following simple method modified from Jacoby (1944) was found suitable for the growth *in vitro* of *Theileria annulata*. A small fragment of infected calf's spleen or lymphatic gland is placed on a sterile glass coverslip and a drop each of calf plasma and chickens' embryonic extract are added. After coagulation the coverslip is sealed to the bottom of a large Carrel flask by a drop of plasma and embryonic extract; 3-5 c.c. of a mixture of 30-40 per cent calf serum in Tyrode is then added and the flask closed and incubated. On this medium Koch bodies survive for at least twelve days, but do not multiply. If fragments of normal spleen are placed in juxtaposition to the infected fragment at intervals of 3-5 days, Koch bodies survive for 15-18 days, but there is no obvious multiplication. The addition of glutamine (3  $\gamma$  per c.c.), pyridoxin (0.6  $\gamma$  per c.c.), inositol (4  $\gamma$  per c.c.) and riboflavine (0.04  $\gamma$  per c.c.) to the mixture of serum and Tyrode induces multiplication of Koch bodies, which was observed in ten successive fragments of normal calf spleen during a period of two months. The addition of these factors to the transplant, in which Koch bodies have survived without multiplication for eighteen days, immediately induced multiplication of the surviving parasites.

It is interesting to note that, *in vitro*, good growths are obtained in spleen fragments of recovered animals

and overlying fluid containing 40 per cent of serum of the same animals. *In vivo* massive inoculation of infected blood or macerated infected lymph glands do not produce an attack of theileriosis in recovered calves, which always harbour a residual infection.

I have to thank Prof. Adler for his advice and Dr. Grossowitz for his kind help.

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July 3.

### Histological Fixation of Locomotory Patterns

NORMAL histological methods usually fail to yield a satisfactory picture of the shape and form of a muscle at any given phase of its activity. For such purposes the following technique has been found useful in the case of small terrestrial or aquatic animals. Absolute alcohol is cooled to about -117° C. by submersion in liquid air. Small terrestrial animals moving over fine wire gauze or thin aluminium foil are quickly dipped into the alcohol, and aquatic animals moving in a small quantity of water contained in a spoon of aluminium foil are treated likewise.

Fixation for histological investigation can be achieved in a number of different ways, according to the material used; for example, dehydration in a frozen condition, gradual thawing in alcohol plus formic acid, etc.

Animals investigated so far include Planarians, Nemertines, Annelids, Gastropods, Myriapods, and small vertebrates. Fixation appears to be instantaneous; the tentacles of snails and slugs remain protracted, and the locomotory waves are clearly recognizable. The setae protrude in the longitudinally contracted segments of an earthworm, and are retracted in the elongated segments.

The details of the method will be discussed elsewhere. It is hoped that it may help to correlate, more satisfactorily than has been possible hitherto, structure and function within the animal body.

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### A Modification of Slide-Culture Technique

A VERY simple and effective method of making slide-cultures for the study of moulds is described below. It has many advantages over the methods described by Henrici<sup>1</sup> (p. 30), Lewis and Hopper<sup>2</sup> (p. 221), Langeron<sup>3</sup> (p. 957), and Smith<sup>4</sup> (p. 176). The procedure, a slight modification of existing methods of slide-culture, was worked out by M. C. White and me jointly, while attached to the laboratories of the South African Institute for Medical Research, Johannesburg, on military duties.

Sterile nutrient agar is melted in a culture tube, in a water bath, and allowed to cool down to between 40°-45° C. This is inoculated fairly heavily with spores of the mould to be studied taken from a pure culture. A very small drop of the inoculated agar is transferred to a flamed slide by means of a platinum loop and is immediately covered over with a flamed coverslip. It should be noted that a hollow-ground

slide is not employed. The agar drop must be of such a size that when the coverslip is gently pressed flat the agar occupies a circle about half the diameter of that of the coverslip.

The slide-culture is incubated in a petri dish, in the bottom of which are a few layers of wet filter paper, the whole having previously been autoclaved. Suitable glass supports raise the slide well above the level of the wet paper. During incubation it is important that the paper should not dry out, and sterile water should be added periodically if necessary. Smith<sup>4</sup> (p. 176) recommends the use of a 20 per cent solution of glycerol instead of water, as the latter tends to wet agar.

On incubation the mycelium spreads rapidly through the agar, and hyphae and sporophores then grow out into the airspace under the coverslip. When a suitable growth has occurred, usually after three or four days, the preparation may be made into a semi-permanent mount by introducing Shear's mounting fluid, with or without added stain, under the coverslip. Air bubbles which are formed are easily removed by placing the preparation in a jar, which is then evacuated by means of a vacuum pump. More durable preparations can then be made by ringing the coverslip with any of the usual ringing cements.

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Division of Botany and Plant Pathology,  
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May 30.

<sup>1</sup> Henrici, A. T., "Moulds, Yeasts and Actinomycetes" (New York, 1930).

<sup>2</sup> Lewis, G. M., and Hopper, M. E., "An Introduction to Medical Mycology" (Chicago, 1939).

<sup>3</sup> Langeron, M., "Précis de Microscopie" (Paris, 1925).

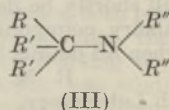
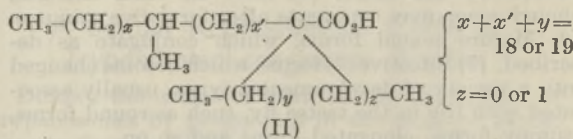
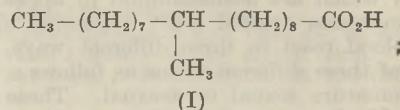
<sup>4</sup> Smith, G., "An Introduction to Industrial Mycology" (2nd Edit., London, 1942).

### Fatty Constituents of Tubercle Bacilli as Growth-inhibitors of the same Bacilli

A most valuable clue in the search for bactericidal compounds has recently been found in the so-called 'antagonism principle' between bacterial vitamins and similarly built molecules of 'antivitamins'<sup>1</sup>. In the field of tuberculosis, this principle is unfortunately of little interest, as the bacilli responsible for this disease seem to need no vitamins for their growth. But an antagonism may be conceived to arise between plastic constituents of tubercle bacilli and substances with very closely related molecular structure, so that such substances can replace the former in the cellular frame without being able to exert any of the necessary vital functions.

Attempting to approach the problem of chemotherapy of tuberculosis from this point of view, I have studied the substitution of a naturally occurring chemical function by an 'unbiological' one, in the very molecules of some constituents of tubercle bacilli. Anderson, Chargaff, Robinson and others<sup>2</sup> have shown that these bacteria contain a fairly high proportion of numerous fatty acids that have not been encountered yet in any other living cell. Only two of these acids have been characterized with sufficient chemical accuracy (the tuberculostearic (I) and the phthiote acids (II)); but it has become clear now that many others are also highly branched-chain molecules. Employing Anderson's method, a mixture of such fatty acids was isolated from the dead bacilli of a virulent stock of human origin,

and distilled in cathodic vacuum to remove the fractions of too high molecular weight, as well as any traces of waxy alcoholic acids. It was converted then, through the acid chlorides and the amides, into a mixture of primary amines, using a slightly modified Jeffreys' method. Whereas the initial material and the amides are practically inactive, the mixture of amines so obtained (in form of the hydrochlorides) proved itself to be strongly bacteriostatic against tubercle bacilli growing on synthetic media (at such high dilutions as 1/10,000 and more). Hence it is clear that a naturally occurring substance endowed with vital properties may be changed into a specifically toxic material through the single replacement of a carboxyl by an amino-group. It is noteworthy that synthetic fatty amines such as (III), prepared from higher fatty amides following Montagne's process<sup>3</sup>, also exhibit more or less bacteriostatic properties against acid-fast bacteria.



Work is in progress in this field, and also to ascertain whether the amidine-group may be of use for the same purpose. But it is perhaps worth while stressing the fact that such an *in vitro* conversion of the constituents of a bacterium into an inhibitor, through the modification of a radical while maintaining the molecular configuration, forms a bridge between chemotherapeutic methods and immunological ones.

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<sup>1</sup> Woods, Fildes, McIntosh, Whitby and others, quoted by Wagner-Jauregg, Th., *Naturwiss.*, 31, 341 (1943).

<sup>2</sup> Anderson, R. J., "Fortschritte der Chemie organischer Naturstoffe", 3, 145 (Vienna, 1939). Chargaff, E., *Ber. deutsch. chem. Ges.*, 65, 745 (1932). Robinson, Sir R., *J. Chem. Soc.*, 507 (1940). Buu-Hoi, Ng. Ph., and Cagniant, P., *Ber. deutsch. chem. Ges.*, 76, 692 (1943).

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### A Case of Molybdenum Deficiency in New Zealand

In a small private-garden investigation into the disease 'whiptail' of cauliflowers, extreme symptoms appeared in those plants not treated with the group of trace elements manganese, zinc, copper and molybdenum. The matter was therefore studied more closely in the glasshouse. In an experiment involving some twenty combinations of two and three of the elements manganese, zinc, copper, molybdenum and





COMPARISON OF MOLYBDENUM-DEFICIENT AND HEALTHY CAULIFLOWER SEEDLINGS. Photo: S. A. Emmerson.

boron with and without lime, and in which phosphate, potash and nitrogen were adequately provided, 'whiptail' failed to develop. At an early stage of growth, however, all plants not supplied with molybdenum developed an intervenal chlorosis very similar to that described by Arnon and Stout<sup>2</sup> in molybdenum-deficient tomatoes. The symptoms were much more pronounced where lime had been omitted. This is in line with a body of evidence<sup>6,7,9,11,12</sup> that soil molybdenum is more available for plant uptake in limed or naturally alkaline soil. The unlimed plants in particular also showed the involution of the leaf edges and marginal necrosis seen in the tomatoes. The addition of sodium molybdate to the soil brought about a rapid recovery of the affected plants. No marked growth differences were associated with the symptoms, and eventually all plants grew out of the condition. The habit of the plants was not normal in the glasshouse and they were not left to reach maturity.

The characteristic leaf distortions of 'whiptail' could very well be caused by a check in growth of the leaf margins. A further small experiment was therefore carried out *in situ* to see if under natural conditions molybdenum might not prove the critical factor. Treatments with and without added molybdenum were compared, phosphate, potash and nitrate being supplied in each case, but no lime. The rate of application of molybdenum (3 lb. of sodium molybdate per acre) may have been a little high, as some germination injury occurred. The contrast between the two treatments was most striking; the plants without molybdenum being chlorotic and making very little progress, while those with the addition were vigorous and dark green in colour. The characteristic mottling was not evident until some growth had been made, the young plants showing a more general chlorosis.

At the present stage, 'whiptail' appears to be developing in some plants of both treatments, and the deficiency described may have no connexion with the disease. 'Whiptail' is usually stated as occurring on very acid soils and as being controlled by heavy liming<sup>3,9,13</sup>. One instance has been described, at

Mickleton, Gloucestershire, on a soil containing free lime.

The soil worked with is an unusually acid phase of Ngaio silt loam (pH 4.7, percentage saturation 35), and the strain of cauliflower Southern Cross.

Molybdenum deficiency has been shown to occur in South Australia<sup>1</sup> and Tasmania<sup>4,5,6,12</sup>; but this is the first instance demonstrated in New Zealand.

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<sup>1</sup> Anderson, A. J., *J. Aust. Inst. Agric. Sci.*, **8**, 73 (1942).

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<sup>12</sup> Stephens, C. S., and Oertel, A. C., *J. Coun. Sci. Ind. Res., Australia*, **16**, 69 (1943).

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## Calomel and Onion Eelworm

MOSLEY has recently suggested<sup>1</sup> that, by liberally dressing onion seed with calomel, control may be obtained not only of onion fly and onion white rot but, possibly, also of the onion eelworm, *Anguillulina dipsaci* (Kühn).

In order to test this, the following experiment was set up. Large numbers of quiescent, infective larvae of *A. dipsaci* were available in the form of eelworm 'wool' obtained from narcissus bulbs in October 1944. The nematodes in this state revive on being moistened and swim freely in water, and it is in this stage that I have shown that they may occur attached to the outside of commercial samples of onion seed<sup>2</sup>. Preliminary tests showed that the eelworms readily revived from the 'wool' when placed in water; the material was thus quite suitable for the intended tests.

Small portions of it a few millimetres in diameter, and each consisting of some hundreds of the parasite, were coated with finely powdered calomel and then placed in fresh garden soil contained in glass tubes 2 in. long by 1 in. wide. Each tube was half-filled with good rich kitchen garden soil. A piece of 'wool', well covered with calomel, was then inserted, and the tube was filled with more soil with the object of ensuring that, if the calomel decomposed in the soil, any of its decomposition products would be in intimate contact with the reviving eelworms. A drop of sterile water was added to each tube sufficient to moisten the soil. A tube without calomel was put up in exactly the same way to serve as a control. All the tubes were then set aside in a moist chamber on the laboratory bench and left for any action to take place. After the lapse of five, eleven and nineteen days, water extracts of the soil from the tubes were made by the Baermann funnel technique. This is a very simple and efficient method for obtaining eelworms from plant material and soil. A piece of rubber tubing is placed on the stem of a glass funnel and is closed by a pinchcock. The funnel is then partly filled with tap water to a convenient depth and clamped in an upright position. The material to

be extracted, wrapped in a piece of cheese-cloth, is then gently submerged in the water and left for an hour or two. Living eelworms soon begin to wriggle out of the material and, sinking down through the water, collect in the stem of the funnel. By opening the pinchcock and running out some of the water into a Petri dish, eelworms can be searched for under the microscope.

In the extracts made in this way from portions of soil from the control tube and from calomel-treated tubes after five, eleven and nineteen days, large numbers of living *A. dipsaci* were obtained swimming freely in the water. The worms from the calomel tubes were just as lively as those from the control tube, thus indicating that the calomel, or its decomposition products, had had no lethal action on the worms reviving from the 'wool'. It seems improbable, therefore, that calomel is likely to prove of service for the control of the eelworm attached to onion seed. If its decomposition products do not destroy the parasite by the nineteenth day after contact (by which time the bulk of the seed in any good sample of onion seed would have germinated) its use as an effective control for seed-borne infections of the eelworm seems to be ruled out. I have determined that the parasite on onion seed can be completely controlled by the fumigation of onion seed with methyl bromide, which does not injure the seed but retards its germination slightly<sup>3</sup>.

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<sup>2</sup> *J. Helminth.*, 21, 22 (1943), issued March 1944.

<sup>3</sup> *J. Helminth.*, in the press.

## Control of Dry Rot of Seed Potatoes by Dusting

At the present time, the only practicable method of controlling dry rot of seed potatoes (*Fusarium cseruleum*) is to dip the tubers immediately on lifting in a solution of one of the proprietary organo-mercury compounds prepared for the purpose<sup>1,2</sup>. This requires large numbers of boxes in which the tubers must be placed to dry—extra labour at an already busy season—since the toxic nature of the dip necessitates the removal of ware potatoes before treatment, and, in many cases, considerable outlay in plant. For these reasons, dipping seems suited mainly to the large specialist growers and not to the smaller farmers whose crops form the bulk of the tonnage concerned.

The wide adoption of any method of control of dry rot depends on (1) effectiveness, (2) absence of deleterious effect on the tubers, (3) ease of application, and (4) small capital outlay on plant. Only a dry treatment appears likely to fulfil all these conditions. In 1938, Dr. R. G. Tomkins, of the Low Temperature Research Station, Cambridge, suggested to one of us (C. E. F.) five volatile compounds which he considered worth testing. These were  $\alpha$ -naphthol, thymol, diphenyl, 4 chlorophenylphenol and 2:5 dichloro-nitrobenzene. Peat was suggested as a suitable carrier. Preliminary experiments showed thymol to be the most promising of these, and large-scale trials with this compound have been carried out during the past three years on Scotch seed, under conditions approaching those found in commercial practice.

Kaolin was used provisionally as a carrier after trials comparing it with peat and gypsum. The rate of application has been 12 oz. thymol, made up to 10 lb. with kaolin, per ton of potatoes. A single application, either on lifting or on riddling for dispatch to England in December or March, has been found to give somewhat variable results; but a double application, that is, both on lifting and on riddling, has been found to provide excellent control of the disease, on the average slightly better than that obtained with the standard single treatment with organo-mercury dip mentioned above.

CONTROL OF DRY ROT BY DUSTING WITH THYMOL KAOLIN. TUBERS TREATED 'AS GROWN' AND CLAMPED ON LIFTING: SEED RE-TREATED ON RIDDLING FOR DISPATCH TO ENGLAND.

Variety	Date dispatched	Dry rot per cent (April)	
		Untreated	Thymol kaolin
Catriona	December	17	1
Arran Pilot	December	46	1
Arran Pilot	March	19	5
Doon Star	December	31	4
Doon Star	March	32	3

These results, subject to confirmation by further trials planned for this season, indicate that the double treatment with thymol kaolin fulfils the first postulate of effectiveness. Unfortunately, however, it does not fulfil the second, as marked phytocidal effects on the tubers were noted in some of the experiments. The exact conditions governing the severity of the damage are not known; but burning has been found to be most severe on wounded surfaces and where tubers were kept in a humid environment after treatment. Immature tubers are thus more subject to damage because of their liability to skin abrasions. Varietal differences also occur; for example, Doon Star has been found to be much less susceptible to thymol injury than Arran Pilot and may be almost undamaged.

The third and fourth postulates, those of ease of handling and small capital outlay, are certainly covered, since dusting on lifting may be done by hand by a boy working with each collecting cart, while treatment on riddling could be accomplished automatically by means of a simple distributor placed over the bag chute. In addition—although further information on this point has still to be obtained—thymol might be considered sufficiently harmless to permit of treating both ware and seed, thus allowing the normal practice of clamping the crop 'as grown' when harvested.

Although the thymol dust cannot be advocated for commercial use unless its burning action can be overcome, the satisfactory level of control obtained shows that there are practical possibilities in the dry method of treatment.

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<sup>1</sup> Foister, C. E., *Scot. J. Agric.*, 23, 63 (1940).

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## RESEARCH ITEMS

## New Genera and Species of Fishes

HENRY B. FOWLER describes two new genera and two new species in recent papers (*Notulae Naturæ*, Academy of Natural Sciences of Philadelphia, "Description of a New Genus and Species of Apogonid Fish from New Jersey", No. 130, April 1944; "Description of a New Genus and a New Species of American Stromateid Fishes", No. 142, June 1944). The first, *Mimocubiceps virginica*, is of special interest, for, besides representing a new genus and species with interesting affinities, it introduces to the New Jersey fish fauna a family (Apogonidae) not hitherto found within the limits of the State. This genus approaches *Erythrobussothen* Parr, but differs in many details. The second genus, *Simobrama*, is proposed for a harvest fish *Seserinus xanthurus* Quoy and Gaimard from Brazil, which is here redescribed, together with a related form, *Pepriulus burti*, new species from the Gulf of Mexico.

## Marine Cottid Fishes of California

IN a detailed review of the family Cottidae, Rolf L. Bolin makes a most useful addition to the literature of the subject (*Stanford Ichthyological Bull.*, 3, No. 1; Oct. 1944). Almost one tenth of the marine fishes of California are members of this family, most of which live in tide pools or are shallow-water species. Identification hitherto has been very difficult and the present work will be a real help to ecologists, parasitologists and other biologists who are not specialists in ichthyology. There is an artificial key to the nineteen genera, each species is carefully described and the majority of them figured, keys being given for the species in many cases. The drawings of these fishes are exceptionally good.

## Callianassidae of the Central Pacific

UNDER this title Charles Howard Edmondson surveys the Callianassidae taken mainly from the shallow reefs at Oahu, Hawaii (*Occasional Papers Berrice P. Bishop Museum*, Honolulu, Hawaii, 18, No. 2; 1944). Several species are described, the most interesting being a new species of *Callianassa* belonging to the sub-genus *Calliacities* (*Callianassa* (*Calliacities*) *parva*), for the author has hatched out its larva. Hitherto no larva belonging to this sub-genus was known, and it is to be hoped that a detailed description of this peculiar form will be forthcoming in the near future. The larva differs from any known *Callianassa* larva in having no dorsal spine on the second abdominal somite and in having a thin spine-like rostrum instead of one that is broad, flat and toothed. The sixth abdominal somite is already formed and the telson is rounded posteriorly with only ten spines instead of the usual fourteen or more. The eyes are exposed and it may be that we have here a case of abbreviated development. Unfortunately the appendages are neither described nor figured. In his latest paper on this group, Gurney (*Proc. Zool. Soc.*, 114; 1944) gives six species the larva of which have been positively identified, four of which belong to the sub-genus *Trypaea*, one to *Cheramus* and one to *Callichirus*. Those belonging to the first two are of the same type and differ from the third, but none of these resembles the form here described. As the larva are probably an important guide to the relationships of the Callianassidae a further description of this new species is much needed.

## Examining the Functional Condition of the Liver

IN *Maroc-Médical* (Dec. 1944), J. Bailly and G. Decrop have an article with the title "A Propos D'Un Procédé D'Exploration Simple De L'Etat Fonctionnel Du Foie", in which they describe minor modifications introduced into Pallardo's method for determining the state of the liver. Briefly, this method consisted in the administration of about 2.5 mgm. of a salt of quinine dissolved in a glass of water, and half an hour and an hour later samples of the urine are examined for the presence of quinine, tests being made by means of Tanret's reaction. In cases of absolutely healthy livers the quinine is completely disintegrated and hence does not appear in the urine. If, however, there should be any delay in the elimination of the quinine which has not been disintegrated, as often occurs, misleading results may be obtained, and Pallardo recommends the prolongation of the period of observation. Certain modifications in the method have been made by Bailly and Decrop because some unsatisfactory features accompany the tests advocated by Pallardo, among which may be mentioned Tanret's reaction. Their procedure is as follows. To 10 c.c. of the urine are added 10 drops of ammonia and then 10-15 c.c. of ether. After stirring the mixture and allowing it to stand for a time, the ether separates and floats on the underlying liquid which is drawn off, and the ether is transferred to a test tube. On adding 2 c.c. of N/10 sulphuric acid and stirring, the acid liquid is precipitated to the bottom of the tube and assumes a beautiful blue fluorescence if quinine is present. Results obtained from sixteen cases are given.

## Germination of Bearded Iris Seeds

THE complexity of the factors affecting seed germination is illustrated in a study by L. F. Randolph and L. G. Cox (*Proc. Amer. Soc. Hort. Sci.*, 43, 284; 1943) on the germination of the seed of the bearded Iris (*Iris germanica*). Cold storage of fairly dry seed at  $-2^{\circ}$  to  $+4^{\circ}$  C. gave increased germination as compared with storage at normal temperatures, but high-temperature ( $35^{\circ}$  C.) storage reduced germination, while alternating high and low temperatures were no more effective than low temperature alone. Wet storage of seeds increased the rate but not the final amount of germination. The importance of the seed coat effect was shown by the fact that excised embryos in nutrient solution and embryos in contact with half the endosperm germinated more rapidly and to a greater extent than did intact seeds. Chipping of the seeds was not effective unless the cap of endosperm covering the radicle was removed, and the effect was further increased if the chipped seeds were leached in running water. Chipped, but not intact, seeds had their germination increased by additional oxygen.

## Root Distribution of Fruit Trees

The failure of fruit trees to respond to fertilizer application may be due to a variety of factors. Sometimes either because of the soil character or the root distribution the added fertilizer fails to reach the absorbing roots. E. L. Proebsting (*Proc. Amer. Soc. Hort. Sci.*, 43, 1; 1943) summarizes studies on the root distribution of fruit trees in a well drained Californian orchard and shows that for cherries, almonds, apricots, peaches and prunes the maximum root concentration is between 2 ft. and 5 ft. deep. There are few roots at a greater depth and few in the surface foot (and these mostly at between 8 in. and

12 in.). In this case, root development nearer the surface is probably inhibited by high summer temperatures and when peach seedlings were grown in containers artificially heated by immersion in water, maximum root growth occurred when the soil temperature was maintained at 75° F. Higher temperatures were deleterious and at 95° F. less root growth occurred than with any other temperature within the range of 45–95° F.

#### Lowering of Sea-Level in Glacial Times

THE question of Quaternary sea-levels is an important one, especially in connexion with geomorphology and the migrations of plants, animals and man. Unfortunately, estimates of the lowering of the ocean surface due to the locking-up of water in the Pleistocene ice-sheets differ very widely. Antevs (1928) arrived at limits of 290–305 ft. for the fall in level due to the last glaciation, while Ramsay (posthumous publication in 1930) suggested limits of 183–275 metres for the lowering due to the maximum glaciation. The difference is out of all proportion to the difference between the volumes of ice involved in these two phases of glaciation. A. Farrington, in the *Proc. Roy. Irish Acad.*, 50, 237 (1945), approaches the problem from a new direction. It is assumed that after the withdrawal of the last European ice-sheet the movements of land and sea were upwards in the main. In these circumstances the only evidence of the return of water to the sea is to be found in natural records of increasing depth. Brøgger's study of the late-glacial deposits of the Oslo Fjord indicates that when the ice stood at the outer Ra, the older Yoldia clay was being deposited in water 10–30 m. deep. The younger Yoldia clay contains a fauna pointing to a depth of 40–60 m., while the later Arca clay has characters appropriate to deposition at 80–100 m. This evidence suggests that 70 m. is a conservative estimate for the rise of sea-level during the interval considered. It is further known that during the later period of the Ancylus Lake the bed of the North Sea was dry land down to 50 m. below the present sea-level. A gap, including the Yoldia Sea period, intervenes between the two rises of more than 70 and 50 m., so that the total rise is at least 120 m., or 400 ft., since the beginning of the ice stand at the outer Ra. Remembering that the bulk of the European ice-sheet had already greatly wasted by the time it had retreated to the outer Ra, it follows, either that the North American ice-sheets melted later, which cannot be lightly assumed, or that the 400 ft. of recorded rise is only a part of the total rise. It is concluded that Antev's estimates of the change of sea-level and of the volume of the ice-masses are much too small.

#### Earthquakes in New Zealand during 1942–43

DURING 1942, 262 earthquakes and earth tremors had their epicentres in New Zealand (*Dominion Obs. Bull.* No. S-69. By R. C. Hayes, Wellington, N.Z. 1944). An epicentral map concerning these shows that by far the majority of the shocks occurred north of lat. 42.5° S., and very few occurred north of Auckland. According to Hayes, the most notable feature of the map is the concentration of activity in the Wairarapa district, due to the large number of subsidiary shocks following the outbreak of activity on June 24, 1942. Two other notable features during the year were: (1) the shock of June 27 with epicentre near White Island and focal depth 230 miles; this is the deepest origin so far recorded in the New

Zealand region; (2) the shock of October 31 in the south-east Tasman Sea, where seismic activity very rarely occurs. During 1943, 213 earthquakes and earth tremors had their epicentres in New Zealand (*Dominion Obs. Bull.* No. S-71. By R. C. Hayes, Wellington, N.Z. 1944). The epicentral map in this case shows the same area as in 1942 covered with epicentres, except that during this year the shock area extended a little farther south, to lat. 43° S. Additionally there was an unusual amount of activity in the south-western portion of South Island, where two shocks reached minor destructive intensity (M.M.7). It was again noted by Hayes that there was a marked concentration of activity in the Wairarapa region, most of the shocks being of slight intensity.

#### Moving-Coil Instruments

THE design of moving-coil instruments includes a consideration of such factors as damping and speed of response, in addition to torque, resistance, etc. A paper by G. F. Tagg (*J. Inst. Elect. Eng.*, 92, Pt. 2, No. 27, June 1945) presents the information necessary to understand the performance of a moving-coil instrument under various conditions in as complete a form as possible, and in such a form that it can readily be used. In the ordinary forms of instruments such as ammeters and voltmeters, the time/deflexion characteristics are of importance in determining the damping and the time of response, but have no effect on the steady reading of the instrument. In special types of instrument, such as the ballistic galvanometer and the flux meter, the time/deflexion characteristics are of importance in determining the reading given by the instrument.

#### 'Cosmic Static'

THIS is the name given by Grote Reber (*Astrophys. J.*, 100, 279; 1944) to naturally occurring short radio waves which reach the earth continuously at an intensity which is found to depend markedly on the direction of arrival. The radiation is apparently closely confined to the plane of the Milky Way. Measurements are made in the range 156–164 Mc./sec. (1.87 metres) with an  $f/0.6$  sheet-metal mirror 30 ft. in diameter mounted so as to swing in the meridian on a horizontal east-west axis. Electromagnetic radiation collected during the earth's rotation from a declination band determined by the elevation of the mirror is focused by it on to an antenna system which converts the waves into alternating current. This is then amplified and rectified and the resulting D.C. voltage drives a pen, which records on a moving tape the intensity of 'cosmic static' against right ascension for a given declination. A glance at specimen records shows that a marked maximum appears on the trace each time the mirror traverses the plane of the galaxy. The radiation becomes unmeasurably small at galactic latitudes above about 30°. There is also a strong dependence on galactic longitude: a main region of disturbance coincides with the direction of the galactic centre in Sagittarius, there are secondary maxima in Cygnus, Cassiopeia, Canis Major and Puppis, and a minimum occurs in Perseus. Though the absolute intensity is small ( $10^{-21}$  watts per megacycle band falling on a square centimetre from a square degree in Sagittarius), the effect is undoubted. Reber points out that the intensity from any direction seems to be roughly proportional to the amount of cosmic material in that direction, but ventures no suggestion as to the mode of production of this extraordinary radiation.

## GROWTH INHIBITION IN PEA SEEDLINGS

By E. DOROTHY BRAIN

THE inhibition of the growth of lateral buds by the application of auxins in high concentrations to the apical surface of cut stems is well known, and it is often associated with marked swelling of the cut stems. Borgström<sup>1</sup> explains both the inhibition and the swelling as being due to increased supplies of auxin set free in a transverse flow from the phloem, induced by the decapitation of the main stem. He considers that the swelling is a secondary effect of the increased auxin supply and not otherwise related to the inhibition of the buds. In the experiments which are described below observations have been made on seedlings of *Pisum sativum* after treatment with *H 11* extract of urine, three fractions of *H 11* and some pure substances. The effect of the various applications on the growth of the cut epicotyls both in height and width and on the development and growth of lateral buds was examined. The plants were grown in pots of soil in the light until three or four internodes high, and then placed in the dark for twenty-four hours before experimenting and for forty-eight hours after treatment, being kept throughout the experiment under glass covers in a moist atmosphere. The inhibiting effect was calculated as the percentage difference between the averages for the total length of the side shoots in treated and control plants.

*H 11* extract is an alcoholic extract of urine prepared by the Hosa Research Laboratories and used for treatment of tumour growth. The concentration of paste used for these experiments was equivalent to 3.5 c.c. *H 11* extract in 6 gm. of pure lanoline. Tests were made with various dilutions of this. Treatment with concentrated paste when epicotyls were decapitated just below the terminal bud caused increased growth of the cut stems and marked swelling at the top of the stems. In plants decapitated at the node below which growth has ceased, treatment caused no increase in the height of cut stems nor did any swelling occur, but lateral buds were inhibited rather more than in the plants which had only the apical part removed.

Three fractions of *H 11* extract were prepared by the Hosa Laboratories: (1) 80 *K* was prepared from the filtrate after the precipitation of neutral *H 11* with copper sulphate; (2) 80 *L* was prepared from the soluble fraction after extracting the precipitate with dilute hydrochloric acid; (3) 80 *M* was prepared by dissolving the tarry substance which remained in 4 *N* sodium hydroxide. Lanoline paste was made with each fraction using 5 c.c. in 3.5 c.c. paraffin mixed with 2 gm. of lanoline. When applied to cut epicotyls 80 *K* and 80 *M* resulted in inhibition to side shoots, but 80 *L* had no inhibitory effect. 80 *L* and 80 *M* both caused greater swelling of the cut stem than 80 *K*. It appears as if 80 *K* contained an inhibitory substance which did not cause stems to swell as the other fractions did. Thompson *et al.*<sup>2</sup> found that 80 *M* was stimulatory to tumour growth.

As it was known that *H 11* extract contained  $\beta$ -indole acetic acid and its sodium salt<sup>3</sup> a comparison was made between the effects of different concentrations of pure  $\beta$ -indole acetic acid and *H 11*, and it was found that a paste containing approximately 6,250 units  $\beta$ -indole acetic acid caused equivalent

inhibition to the concentrated *H 11* paste but less swelling of the stems. Series of experiments, in which paste made with a solution of  $\beta$ -indole acetic acid neutralized with sodium hydroxide was used, showed more swelling in the stems treated with the sodium salt than with the acid. The presence of the sodium salt in *H 11* extract would therefore account for the marked swelling noted in the cut stems. Avery<sup>4</sup> has recorded that the potassium salt of  $\beta$ -indole acetic acid is twice as active as the acid in the *Avena* test.

Analysis of *H 11* extract<sup>5</sup> having indicated the presence of a member of the quinone series, it was considered useful to test the effect of similar substances on cut stems. The following solutions were therefore used: (1) a saturated solution of anthraquinone in distilled water; (2) anthraquinone 2.6 di-sulphonic acid refined sodium salt, 0.1 per cent in distilled water; (3) 1.5 di-hydroxy anthraquinone, 0.1 per cent in distilled water. Results of these experiments showed a slight increase in the height of cut stems and inhibition of the growth of side shoots after treatment with anthraquinone and anthraquinone 2.6 di-sulphonic acid refined sodium salt. 1.5 di-hydroxy anthraquinone caused less increase in the height of the cut stems and increased growth of side shoots. No swelling of the stems occurred.

### *Pisum sativum* epicotyls

Applications to cut stems	Percentage inhibition of lateral shoots	Percentage increase in width of cut stems
<i>H 11</i> extract	70.2	150.0
Fractions of <i>H 11</i>		
80 <i>K</i>	42.86	50.0
80 <i>L</i>	—	100.0
80 <i>M</i>	41.67	100.0
$\beta$ -indole acetic acid, 6,250 units per gram lanoline	69.6	76.8
Anthraquinone saturated solution	73.4	—
Anthraquinone 2.6 di-sulphonic acid refined sodium salt 0.1 per cent	54.4	—
1.5 di-hydroxy anthraquinone 0.1 per cent	—	—

A comparison of the amount of inhibition and swelling caused by these different applications is given in the accompanying table. It is evident from these results that substances which cause inhibition may not cause swelling in the stem and that auxin application may inhibit without causing swelling if the actively growing internodes of the stem are removed.

Snow<sup>6</sup> states that the inhibitive influence travelling up the lateral shoot is a hormone other than auxin and finds evidence in his experiments that another substance is active in inhibiting lateral buds in pea seedlings. No previous record has been found of inhibition by substances other than auxin when applied apically to the cut stem, and it is hoped to carry out more experiments to test the inhibition of other substances along these lines.

I am indebted to Mr. J. H. Thompson, director of research of Hosa Research Laboratories, for providing the *H 11* extracts and other substances.

<sup>1</sup> Borgström, Georg, "The Transverse Reactions of Plants", 126-131 (Lund: C. W. K. Gleerup; Copenhagen: Ejnar Munksgaard; London: Williams and Norgate, Ltd., 1939).

<sup>2</sup> Thompson, J. H., Holt, P. E., and Jones, R. Forbes, *Nature*, 151, 23 (1943).

<sup>3</sup> Thompson, J. H., *Brit. Med. J.* (July 31, 1943).

<sup>4</sup> Avery, George S., Jr., Buckholder, P. R., and Creighton, Harriet B., *Amer. J. Bot.*, 24, 226 (1937).

<sup>5</sup> Thompson, J. H., "Cancer Research", *Medical World* (Oct. 13, 1944).

<sup>6</sup> Snow, R., *New Phyt.*, 39 (2), 177 (1940).

# CELL PROLIFERATION, CARBOHYDRATE BREAKDOWN, AND HYDRATION OF ENZYME PROTEIN

By DR. A. LASNITZKI

Department of Physiology, University of Birmingham

THE interesting result that the rate of anaerobic glycolysis of embryonic and post-embryonic tissue, from a warm-blooded animal, decreases gradually in successive stages of development<sup>1,2</sup> has demonstrated a close relationship between enzymatic breakdown of carbohydrates, particularly that of glucose, and the proliferation of tissue cells, having regard to the fact that, in general, the rate of this proliferation likewise diminishes as development progresses<sup>3</sup>. The significance of this parallelism has further been emphasized by the result that, in normal tissues, the rate of anaerobic glycolysis corresponds approximately to the rate of carbohydrate oxidation under aerobic conditions<sup>4</sup>.

The most appropriate interpretation of the relation appears to be that the energy required for cell proliferation originates, directly or indirectly, in carbohydrate breakdown; in particular, this view indicates that the relation must hold for any type of growing tissue, including tumour tissue, the latter possessing a considerable ability to metabolize glucose, although this is, even under aerobic conditions, largely confined to an oxidative glucose splitting<sup>1,2,4</sup>. A distinction must be made, however, between the *supply* of energy by a process of this kind and the final *utilization* of that energy for the purpose of growth, and the possibility of a disconformity between these two factors must be considered in estimating the result that, in the case of tumours, rate of cell proliferation and intensity of glycolysis have not shown throughout the same clear relation obtained with tissues growing normally<sup>5</sup>. On the other hand, in certain tissues of the adult organism (for example, nervous tissue), in which cell proliferation has come to an end, although a relatively high carbohydrate metabolism persists<sup>4,6</sup>, it is an obvious assumption that the liberated energy will be utilized for the maintenance of specialized functions.

Another fact of relevant interest is provided by the observation, frequently noted, that the water content of the entire animal body as well as of individual tissues gradually decreases in the course of embryonic and post-embryonic development, so that rapidly growing tissues, that is, tissues with intense cell proliferation, as a rule contain more water than corresponding tissues growing at a slower rate<sup>6</sup>. A very similar relation was found for tumour tissue<sup>7</sup>. In all probability, the increase in tissue water is due in great part to a rise in water content of the cellular constituents, and this rise is likely to be associated with an increased hydration of cell proteins. The most important kinds of proteins, in this connexion, appear to be those which constitute the protein components of enzymes, and, in particular, of such enzymes as are involved to a varying extent in the breakdown of carbohydrates.

These considerations suggest, therefore, that the intensity of carbohydrate breakdown in a growing tissue, and consequently the rate of cell proliferation, depends largely on the degree of hydration of corresponding enzyme proteins, so that, within limits, an increase in hydration stimulates and a decrease

inhibits that enzymatic activity<sup>8</sup>. The suggestion attempts to elucidate the biological significance of the increased water content of rapidly growing tissues by relating it, through the concept of protein hydration, to the metabolic process which serves as the source of energy for cell proliferation; and the order of causation thus supposed can be represented as follows:

<sup>1</sup>  
 Degree of hydration of enzyme proteins involved in carbohydrate breakdown → <sup>2</sup>  
 Intensity of carbohydrate breakdown → <sup>3</sup>  
 Rate of cell proliferation.

Some experimental evidence regarding the validity of relation 1 → 2 may be obtained from the results of studies on the action of ions upon glycolysis and related processes. Thus it was found<sup>9</sup> that the splitting of 'lactacidogen' (probably a hexosephosphate) by frog muscle could be modified under the influence of various anions in a manner which, on the whole, corresponded to their position in the Hofmeister series, anions with hydrating effects upon proteins (and hydrophilic colloids in general) causing an acceleration, and those with dehydrating effects an inhibition, or even reversion, of the process. As to warm-blooded animals, a number of investigations<sup>10</sup> have shown the pronounced inhibitory effect of fluoride upon the glycolytic activity of normal tissues and tumours, an effect which agrees with the strongly dehydrating power of that anion; while other studies<sup>11,12</sup>, likewise performed with both normal and tumour tissue, have shown that glycolysis, as well as carbohydrate oxidation, could be markedly stimulated by potassium, a cation which favours hydration.

<sup>1</sup> Warburg, O., "The Metabolism of Tumours", translated by F. Dickens (London, 1930) (collected publications by Warburg and co-workers); also Warburg, O., and Kubowitz, F., *Biochem. Z.*, **189**, 242 (1927).

<sup>2</sup> Rosenthal, O., and Lasnitzki, A., *Biochem. Z.*, **196**, 340 (1928).

<sup>3</sup> As to this point, see specially: Minot, C. S., "The Problem of Age, Growth, and Death" (London, 1908).

<sup>4</sup> Dickens, F., and Šimer, F., *Biochem. J.*, **24**, 1301 (1930); **25**, 985 (1931).

<sup>5</sup> Boyland, E., and Boyland, M. E., *Biochem. J.*, **33**, 618 (1939).

<sup>6</sup> For references: Aron, H., in "Handbuch der Biochemie", edited by C. Oppenheimer, **7**, 152 (Jena, 1927). Needham, J., "Chemical Embryology", **2**, 870, 883 (Cambridge, 1931).

<sup>7</sup> Cramer, W., *J. Physiol.*, **50**, 322 (1916).

<sup>8</sup> Cf. Lasnitzki, A., *Z. Krebsforsch.*, **27**, 115 (1928).

<sup>9</sup> Embden, G., and Lehnartz, E., *Hoppe-Seyl. Z.*, **134**, 243 (1924).

<sup>10</sup> For example: Dickens, F., and Šimer, F., *Biochem. J.*, **23**, 936 (1929). Sella, C., and Jány, J., *Biochem. Z.*, **239**, 94 (1931).

<sup>11</sup> Lasnitzki, A., see ref. 8; *Biochem. Z.*, **264**, 285 (1933); *Protoplasma*, **22**, 274 (1934). Lasnitzki, A., and Rosenthal, O., *Biochem. Z.*, **262**, 203 (1933).

<sup>12</sup> Ashford, C. A., and Dixon, K. C., *Biochem. J.*, **29**, 157 (1935). Dickens, F., and Greville, G. D., *Biochem. J.*, **29**, 1468 (1935).

## TWO NEW ANTIBIOTICS

IN a note in *Nature* of November 18, 1944, p. 631, attention was directed to the need for an anti-septic or antibiotic which would effectively control infections with Gram-negative micro-organisms, many of which are not susceptible to penicillin. Among these are the typhoid-dysentery group of organisms, *Brucella*, *Hæmophilus* and those common invaders of wounds, *Proteus vulgaris* and *Pseudomonas pyocyaneus*. The tubercle bacillus is also resistant to penicillin. A reference has now appeared (*Brit. Med. J.*, 706, May 19, 1945) to two new antibiotics derived from soil Actinomycetes which do act upon various Gram-negative organisms and also seem to inhibit the development of tuberculosis in guinea pigs. They

have been isolated by S. A. Waksman and his colleagues (*Proc. Mayo Clin.*, 19, 537; 1944; and *Proc. Soc. Expt. Biol., N.Y.*, 55, 66; 1944) and are called 'streptomycin' and 'streptothricin'. Streptomycin seems to be the more valuable of the two. It is obtained from *Actinomyces griseus* and, like streptothricin, is very stable and resists moderate heat, storage and the action of most other organisms, in marked contrast to penicillin. It appears to be an organic base, soluble in water, but not in ether and chloroform. It inhibits *in vitro* the growth of human strains of the tubercle bacillus, the Gram-positive *B. subtilis* and *Staphylococcus aureus*, and the Gram-negative *Bact. coli*, *Brucella abortus*, *Bact. aerogenes* and various organisms of the *Salmonella* and dysentery groups. It has, unlike penicillin, a moderate inhibitory action upon the growth of *Proteus*, *Salmonella aertrycke* and *Pseudomonas pyocyanea*. Its toxicity to animals is fairly low. The antibacterial action of streptothricin is similar, but less powerful; and it acts upon fewer organisms.

No clinical trials have yet been reported with these substances, but tests done on mice show that streptomycin very effectively protects mice against mixed infections with *Proteus vulgaris* and an anaerobic streptococcus, both obtained from a human infection. Good results have followed the treatment with streptomycin and streptothricin of mice and chick embryos infected with various *Salmonella* species and with *Brucella abortus*. Heilman (*Proc. Mayo Clin.*, 19, 553; 1944) has reported that *Pasteurella tularensis*, the cause of tularæmia, which is not affected by sulphonamides or penicillin, is three times as sensitive as *Bact. coli* to streptomycin, which prevents infection of mice with *P. tularensis*. Feldman and Hinshaw (*Proc. Mayo Clin.*, 19, 593; 1944) have shown that, in guinea pigs inoculated with virulent tubercle bacilli and treated for sixty days with streptomycin, tuberculosis was scarcely detectable microscopically, although viable bacilli were still present, while the control animals not so treated showed widespread tuberculosis. The antibacterial action of streptomycin is, these authors think, comparable to that of promin, which they also studied.

It is clear that streptomycin and streptothricin urgently require further clinical study. An important obstacle to their clinical trial on a sufficiently extensive scale may well be the difficulty of producing them in sufficient quantity, and it is to be hoped that it will be possible to overcome this. There is considerable evidence that, although the remarkable properties of penicillin justify all the effort that is being expended upon it, that effort must not distract attention from the other antibacterial substances which are being constantly isolated from an increasing variety of living organisms. Among these the soil bacteria are important. The properties of gramicidin and gramicidin S, obtained from soil bacteria, were noted recently in *Nature* (246, Feb. 24, 1945). Another heat-stable substance which is chemically similar to, but apparently not identical with, the gramicidin isolated by Hotchkiss and Dubos in America (see *J. Exp. Med.*, 73, 629; 1941 and other papers) has been isolated by J. C. Hoogerheide (*J. Bact.*, 40, 415; 1940, and *J. Franklin Inst.*, 229, 677; 1940) from soil bacteria. It prevents the formation of the capsule by Friedländer's bacterium, types A and B. Its chemical, therapeutic and other properties are summarized by E. McDonald (*J. Franklin Inst.*, 229, 805; 1940). Dr. V. W. Murray Wright reported that the material originally isolated by

Hoogerheide from the bacteria was "very valuable and safe" for the treatment of external lesions in human patients. Dr. Wright (*J. Franklin Inst.*, 233, 188; 1942) also reports on a series of ninety human cases infected with Gram-positive organisms and treated with what is apparently the same substance (designated H 1). The organisms rapidly disappeared and healing was stimulated. G. LAPAGE.

## UNITED STATES ANTARCTIC DISCOVERIES

THE work of the United States Antarctic Service Expedition of 1939-41 has been overshadowed by war and was little known in Great Britain. The volume now published (Reports on the Scientific Results. New York: *Proc. Amer. Phil. Soc.*, 89, No. 1, 1945) gives full accounts of all aspects of the expedition's work in a long series of papers, many of which are well illustrated but none of which is well supplied with maps.

This was Admiral R. E. Byrd's third expedition, but the first official United States expedition to the Antarctic for a hundred years. It was well equipped and carried a large scientific staff to its two bases, the east base in Marguerite Bay, Graham Land, wrongly called the Palmer Peninsula, and the west base at the Bay of Whales on the Ross Barrier. The first was new territory for the Americans; the second was in an area where much American work had already been done, but it seems, at the least, ungracious to reduce Scott's King Edward VII Land to a mere peninsula of Marie Byrd Land.

Discoveries made by plane and sledge journeys were noteworthy, and geological work was a feature of all land travel. Several of the most important papers in this symposium are by Lieut.-Com. R. B. Black, Com. F. Ronne, Major P. A. Siple, Major F. A. Wade, L. A. Warner, C. F. Passel, P. H. Knowles and Prof. D. Stewart. A sledge journey along King George VI Sound and a flight west of Alexander I Island carried the map west of the discoveries of the Rymill expedition. Alexander I Land is certainly an island, and west of it lies the much smaller Charcot Island. West of King George VI Sound the coast-line seems to run mainly east and west to high land in about long. 95°-100° W. South Graham Land is a plateau of some 4,000-5,000 ft. uncut by straits, and facing the Weddell Sea is the lofty edge of the George Black Range in about long. 60° W. from about lat. 72° S. to 77° S.

On the other side of Antarctica, the Edsel Ford ranges of Marie Byrd Land were well explored, and the coast-line, Hobbs Coast, continued east of Cape Rupert. Several flights across the Ross Barrier were also made. Evidence was found of several small islands under the Barrier, smaller than Roosevelt Island. There was little evidence of the Barrier having calved in recent years. It is suggested that the Bay of Whales is the meeting-place of two shelf-ice systems, on the western side from the south and on the eastern from the south-east. These systems thus cause crumbling of bay-ice in that area. No suggestion was noted of sea-level connexion between the Ross and Weddell Seas.

Some light was thrown on the problem of the relationship of the Andean structure of Graham Land with the predominant plateau structure of the

greater part of Antarctica. The Rockefeller Mountains of King Edward Land and the Edsel Ford ranges of Marie Byrd Land are both a series of north-west trending folds of metamorphics and acid intrusives: "No true relationship is indicated between this unit and any of the previously described Antarctic localities". But on the whole the affinities seem to be with the Andean structure. The new land examined in the south of Graham Land is definitely Andean in structure, though the Weddell Sea coast has a definite block fault topography with much granite and slate.

Many other valuable researches are discussed in this volume.

R. N. RUDMOSE BROWN.

## FORTHCOMING EVENTS

### Monday, October 1

BRITISH MUSEUM (NATURAL HISTORY), South Kensington, London, S.W.7, at 2.30 p.m.—Dr. J. Ramsbottom, O.B.E.: "Edible Fungi". Also on Mondays and Fridays until October 26.

ROYAL INSTITUTION (Albemarle Street, London, W.1), at 5 p.m.—Lord Rayleigh, Sir Robert Robertson, Sir Richard Paget, Mr. R. S. Whipple, Prof. W. V. Mayneord and Sir Henry Dale: "Life and Work of Major C. E. S. Phillips".

SOCIETY OF ENGINEERS (at the Geological Society, Burlington House, London, W.1), at 5 p.m.—B. A. P. Winton Lewis: "The Engineer and the Housing Problem".

SOCIETY OF CHEMICAL INDUSTRY, LONDON SECTION (at the Chemical Society, Burlington House, Piccadilly, London, W.1), at 7.15 p.m.—Dr. E. S. Hedges: "New Developments in Tin and Tin Alloy Coatings".

### Wednesday, October 3

INSTITUTE OF WELDING (at the Institution of Civil Engineers, Great George Street, London, S.W.1), at 6 p.m.—Mr. W. K. B. Marshall: "The Fabrication of Aircraft Fuel Tanks in Aluminium Alloy containing 3% Magnesium" (Sir William J. Larke Medal Prize Paper).

SOCIETY OF PUBLIC ANALYSTS AND OTHER ANALYTICAL CHEMISTS (at the Chemical Society, Burlington House, Piccadilly, London, W.1), at 6.30 p.m.—Mr. Eric C. Wood: "The Theory of certain Analytical Procedures, with special reference to Microbiological Assays".

### Thursday, October 4

ROYAL COLLEGE OF SURGEONS OF ENGLAND (Lincoln's Inn Fields, London, W.C.2), at 5 p.m.—Dr. Leslie Foulds: "Observation and Theory in Cancer Research" (Imperial Cancer Research Fund Lecture).

CHEMICAL SOCIETY (at Burlington House, Piccadilly, London, W.1), at 5 p.m.—Dr. U. R. Evans: "Recent Work on Corrosion and Oxidation Reactions".

INSTITUTION OF ELECTRICAL ENGINEERS (at Savoy Place, Victoria Embankment, London, W.C.2), at 5.30 p.m.—Dr. P. Dunsheath: Inaugural Address as President.

### Friday, October 5

BRITISH RHEOLOGISTS' CLUB (at the Engineers' Club, Manchester), at 11 a.m.—Business Meeting; at 2 p.m. (joint meeting with the MANCHESTER SECTION OF THE OIL AND COLOUR CHEMISTS' ASSOCIATION)—Discussion on "General Rheological Properties of Suspensions" (to be introduced by Mr. J. Pryce Jones and Mr. W. F. Carey).

ASSOCIATION OF APPLIED BIOLOGISTS (at the London School of Hygiene and Tropical Medicine, Keppel Street, London, W.C.1), at 11 a.m. and 2.15 p.m.—Symposium on Some Agricultural Uses of D.D.T.

PHYSICAL SOCIETY (at the Physics Department, Imperial College, London, S.W.7), at 5 p.m.—Dr. D. H. Smith: "A Method for obtaining small Mechanical Vibrations of known Amplitude"; Dr. S. R. Pelc: "The Photographic Action of X-Rays"; Rev. G. D. Yarnold: "The Hysteresis of the Angle of Contact of Mercury".

SOCIETY OF CHEMICAL INDUSTRY, PLASTICS GROUP AND GLASGOW SECTION (at the Royal Technical College, Glasgow), at 7.15 p.m.—Prof. H. W. Melville: "Structure and Synthesis of Vinyl Plastics".

## APPOINTMENTS VACANT

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

TWO ASSISTANT LECTURERS IN APPLIED MATHEMATICS in the University of Liverpool—The Registrar (Oct. 1).

PRINCIPAL at a Farm Institute for Training ex-Service men, to be opened in Norfolk—Executive Officer, Norfolk War Agricultural Executive Committee, Sprowston, Norwich (Oct. 3).

DISTRICT OFFICER to the Berkshire War Agricultural Executive Committee—The Secretary, 1 Abbot's Walk, Reading (Oct. 6).

LECTURER IN ORGANIC CHEMISTRY at the Mid-Essex Technical College, Market Road, Chelmsford—Chief Education Officer, County Offices, Chelmsford (Oct. 6).

LECTURER with special responsibility for AERONAUTICAL ENGINEERING at the Technical College, Coventry—Director of Education, Coventry Local Education Authority (Oct. 8).

GRADUATE TEACHER OF ELECTRICAL ENGINEERING and allied subjects at the School of Engineering and Navigation, High Street, Poplar, London, E.14—The Education Officer (T.1), County Hall, London, S.E.1, on application form T.1/40, for which a stamped addressed envelope should be sent (Oct. 8).

LECTURER IN GEOGRAPHY at the London School of Economics and Political Science, Houghton Street, London, W.C.2—The Secretary (Oct. 8).

GRADUATE ASSISTANT to teach ENGINEERING SUBJECTS at the Stockton-on-Tees Technical School—The Director of Education, Shire Hall, Durham (Oct. 10).

One CHIEF CHEMIST (Ref. F.4816.XA), four ASSISTANT CHEMISTS (Ref. F.4817.XA), and one ASSISTANT MECHANICAL ENGINEER (Ref. C.2797.XA), in a South American spinning rayon plant—The Ministry of Labour and National Service, Appointments Department, Technical and Scientific Register, Room 670, York House, Kingsway, London, W.C.2, quoting appropriate Ref. No. (Oct. 12).

DIRECTOR-GENERAL OF THE BRITISH PRODUCTION ENGINEERING RESEARCH ASSOCIATION—The Association, Box A.1183, *The Times*, London, E.C.4 (Oct. 19).

DEVELOPMENT ENGINEERS (copper and copper alloys), one ELECTRICAL (D.1388.XA) and one MECHANICAL (C. 2736.XA)—The Ministry of Labour and National Service, Appointments Department, Technical and Scientific Register, Room 670, York House, Kingsway, London, W.C.2, quoting appropriate Ref. No. (Oct. 19).

DISTRICT ENGINEER (civil) for the Sudan Government—The Ministry of Labour and National Service, Appointments Department, Technical and Scientific Register, Room 670, York House, Kingsway, London, W.C.2, quoting E.1954.A (Oct. 20).

DIRECTOR OF RESEARCH, Institution of Automobile Engineers—The Chairman of the Institution, Research Department, Great West Road, Brentford, Middlesex, marked "Director of Research" (Oct. 20).

TWO DISTRICT LOCOMOTIVE SUPERINTENDENTS for the Sudan Government—The Ministry of Labour and National Service, Appointments Department, Technical and Scientific Register, Room 670, York House, Kingsway, London, W.C.2, quoting C.2798A (Oct. 20).

PHYSIOLOGIST at the Laboratory of the Marine Biological Association of the United Kingdom, Citadel Hill, Plymouth—The Secretary (Oct. 31).

CURATOR OF VERULAMIUM MUSEUM, St. Albans—The Town Clerk, St. Albans, endorsed "Curator" (Oct. 31).

SUB-LIBRARIAN in the University Library, St. Andrews—The Librarian (Nov. 1).

DEPUTY CITY ANALYST, City and County of Bristol—The Medical Officer of Health and Professor of Preventive Medicine, Department of Public Health, Kenwith Lodge, Westbury Park, Bristol 6, endorsed "Deputy City Analyst" (Nov. 3).

JACKSON CHAIR OF ENGINEERING in the University of Aberdeen—The Secretary (Nov. 15).

RUTHERFORD MEMORIAL RESEARCH FELLOWSHIP (physics, chemistry and/or mathematics) at Canterbury University College, Christchurch, New Zealand—The Secretary, Universities Bureau of the British Empire, care of University College, Gower Street, London, W.C.1 (applications to reach New Zealand by January 31, 1946).

DEMONSTRATOR IN PHYSICS at Guy's Hospital Medical School, London, S.E.1—The Dean of the School.

CHIEF DEVELOPMENT ENGINEER to the Research and Development Department, United Steel Companies, Ltd.—The Secretary, 17 Westbourne Road, Sheffield, 10.

CHAIR OF MINING AND METALLURGY, CHAIR OF ELECTRICAL ENGINEERING, and CHAIR OF MECHANICAL ENGINEERING, University of Adelaide—The Secretary, Universities Bureau of the British Empire, care of University College, Gower Street, London, W.C.1.

HEAD OF THE ENGINEERING DEPARTMENT, Municipal College, Bournemouth—The Director of Education, Town Hall, Bournemouth.

PRINCIPAL OF THE LOWESTOFT TECHNICAL INSTITUTE—The Chief Education Officer, County Education Department, County Hall, Ipswich.

LECTURER IN ELECTRICAL ENGINEERING, and LECTURER IN MECHANICAL ENGINEERING, in the Nottingham and District Technical College—The Acting Clerk to the Governors, Education Office, South Parade, Nottingham.

ASSISTANT (graduate in zoology or physiology) FOR CANCER CHEMOTHERAPY INVESTIGATIONS—Hosa Research Laboratories, Sunbury-on-Thames.

TECHNICAL ASSISTANT in the GEOLOGY DEPARTMENT, University of Birmingham—Prof. L. J. Wills.

ASSISTANT LECTURER and DEMONSTRATOR IN PHYSICS at the Royal Holloway College, Englefield Green, Surrey—The Principal.

LECTURER IN PHYSICS at the Stockport College for Further Education—The Deputy Director of Education, Education Offices, Town Hall, Stockport.

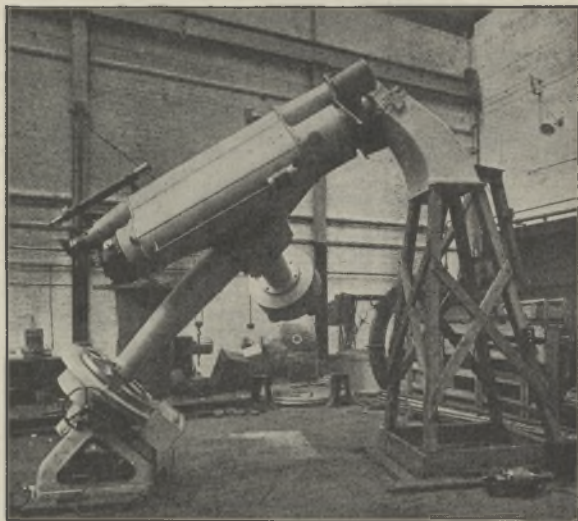
GRADUATE LECTURER IN MECHANICAL ENGINEERING SUBJECTS at the Kingston Technical College—The Principal.

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Applications, stating date of birth, nationality, present employment, particulars of qualifications and experience, accompanied by copies of not more than 4 testimonials, should reach the Secretary, Australian Scientific Research Liaison Office, Australia House, Strand, London, W.C.2, not later than November 12, 1945.

(Signed) G. A. COOK,  
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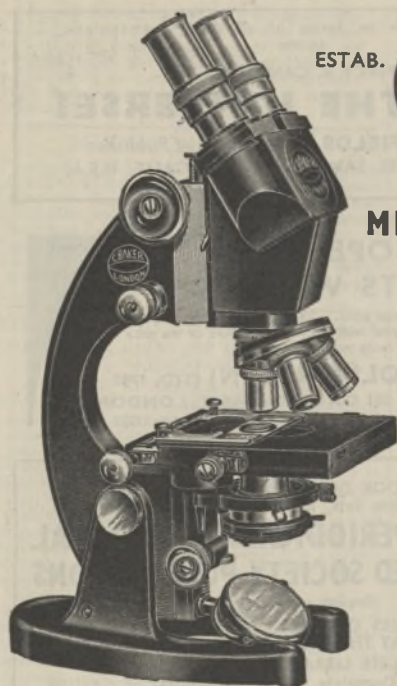
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