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MOBILIZATION OF MENTAL POWER

THE relatively late rise of psychology among the sciences is partly due to the fact that its subject-matter is so wrapped in prejudice and entangled in tradition that it is most difficult to examine in a detached and scientific spirit. The obstacles preventing the application of precise psychological information to personnel selection in the army, where tradition is so deeply entrenched, would seem to be particularly forbidding, and the Select Committee on National Expenditure is to be congratulated for devoting one of its reports to this topic*.

One immediate effect of the introduction of intelligence tests in the United States Army in 1917 was the discharge of about eight thousand men on account of mental defect, the transference of about ten thousand to labour battalions and the recommendation that a further ten thousand required special training which would allow for their low ability. Since the War of 1914–18, the measurement of intelligent behaviour has made notable advances both in theory and practice (although, judging by conditions in contemporary society, a parallel progress is far from evident in the trait to be measured), and it can confidently be anticipated that the outcome of a major testing programme carried out now would involve results of great consequence.

* Twenty-Second Report of the Select Committee on National Expenditure. (London: H.M. Stationery Office, 1941.)

In spite of the increase in mechanization, it still remains true that the human element in warfare is, in the long run, more important than technical devices. A necessary condition of the efficiency of any mechanism, organism or organization is that every component should be optimally situated in relation to the whole. To each constituent part should be assigned its most appropriate function. For society to attain that stage of efficiency so essential in total war, full use should be made, so far as is humanly possible, of all the native ability and skill, all the training and qualities of personality that are available. In so far as we fall short of this objective, to that extent are we inefficient. It is, of course, assumed that the supply of talent, innate and acquired, should be related to the military and civilian needs of the nation at war.

The review by Dr. C. S. Myers in NATURE of May 10, 1941, of the applications of psychology already achieved in the present War, indicated the many possibilities of utilizing psychological methods in the Fighting Services and industry. Several examples were quoted in which individuals had utilized such methods, but there is little sign that those in authority regard them as more than interesting experiments.

The report of the Select Committee recognizes that many mental tests in use until now have not fulfilled the selective functions for which they were presumably designed. No doubt this can be attributed partly to the extended use of verbal rather than perceptual and performance tests. Apart from the existing evidence, which points to a verbal factor orthogonal to intelligence, the use of verbal tests puts schooling at a premium and does not effectively discriminate between the native ability of persons differing widely in educational background, as must be the case in a conscript army.

It is unfortunate that the outworn idealistic belief that abilities are mere entities seated in the mind still makes its influence felt in test construction. A more realistic approach is desirable. So far as the Services are concerned, the guiding principle should be the need for selecting persons capable of performing the tasks required by the more specialized units of the armed Forces. The ability should be defined by the test, not the test by the ability ; and the design of the test should, in general, be determined by the activities called into play in the actual performance of the work for which selection is needed.

The elimination of feeble-minded and backward soldiers before money and training have been wasted upon them ought to present no difficulty ; tests are available, specially built to deal with these problems. But the careful segregation or placing of neurotic types needs the employment of a new kind of criterion. The Committee's recommendation that the Ministry of Labour and National Service should, in future, not be responsible for posting men to any particular corps but only to the army as a whole, will it is hoped, be put into effect with as little delay as possible.

The suggestion that the testing should rest entirely in the hands of Service personnel is open to criticism. It needs to be stressed that so far as possible the testing in all its stages should be under the control and supervision of qualified psychologists, with a status similar to that of the existing medical boards. Otherwise, the scheme is likely to defeat its own ends. Serious defects in the conditions of administration of the tests can invalidate the results, as may happen if the work is entrusted to officers who have only been given some slight instruction in the preliminaries of testing. The following instances taken from a mechanized unit are instructive. An officer charged with the administration of the tests was accustomed to inform the candidates, after imparting other misleading information, that "they all had an equal chance of doing equally well on the tests", which is the very opposite of the truth. The period immediately prior to the testing was frequently spent 'on the square' and the men were consequently in various stages of fatigue. No account seems to have been taken of poor health at the time of the test. Furthermore, a well-intentioned sergeant apparently always did his best to assist the men in the test ; he thought it was the correct thing to do. Copying also went on.

The advantages that would have followed the introduction of scientific methods of selection before or at the outbreak of war will, it seems, be largely obviated because the bulk of the men in the Forces have already received their training and, in the present circumstances of war, transfers on a large scale are considered undesirable. This is recognized by the Select Committee. However, if it is too late in one sphere, the moment is opportune to begin in another. Now is the time to sort out the thousands of youths that have joined the Air Training Corps. Here it is possible, with the aid of psychological tests, to achieve a great economy in time and expense by providing a differential training according to capacity and temperament.

The sphere in which purely psychological criteria of selection, in addition, of course, to physiological tests, could reap their greatest reward is probably that of pilot selection. Now, while there is no reason to question that the medical authorities have availed themselves of the best diagnostic techniques, there are grounds for believing that the possible contributions which psychology has to offer in this urgent field have by no means been fully explored. No effort should be too great to select, with the utmost care, the relatively small number of future pilots out of a much larger number of candidates. It is here that, added to the minimum requirements of intelligence, the qualities of temperament and character exert their most crucial effects. The problems are exceedingly complex. Nevertheless, the traits subserving mental stability, persistence, prolonged attentive power or the capacity to respond rapidly to a succession of surprise stimuli, to mention a few, should not wholly elude measurement. Those characteristics by which a day fighter pilot may be discriminated with a maximum of accuracy from the night fighter pilot and both from the bomber pilot merit all the resourcefulness and imagination in psychological measurement which are available.

The use of diagnostic criteria of ability in the selection and promotion of officers is also advocated by the Select Committee. It would be interesting to know how this would affect the existing distribution of ability among the commissioned ranks. However, given a certain level of intelligence, stress is laid in the report upon qualities of personality, and new experimental methods of assessing the relevant qualities are urgently needed. The system of promotion by seniority, wherever it is employed, is not necessarily calculated to elevate to posts of greater responsibility those men who are distinguished by superior talents. If anything, increase in age beyond a certain point is probably inversely correlated with many of the qualities which make for success as a soldier. An officer, as a result, let us say, of bravery in the field, may be given a post in which matters relating to strategy are decided by him. But it cannot be assumed that the biological and social factors which operate to select for the quality of courage are the same as those which select for the traits which make a good strategist. Other considerations, which arise wherever appointments are to be determined by experience or by more direct estimates of capacity, also deserve weight. It may happen that a soldier with considerable military experience is entrusted with a high post mainly on this ground ; but what is really relevant is the capacity to profit from experience rather than the mere fact of having had experience, and the appointment should be determined at least as much by the former as by the latter.

The scope of psychological methods in the organization of war is not confined to the application of mental tests in the Services. The allocation of new labour in industry, the human element in production, propaganda, morale and evacuation are some of the problems the solution of which would be facilitated were the aid of psychology more fully enlisted. The greatly increased number of trained psychologists which would be required could probably be provided by the Central Register, with the added advantage that the special qualifications of many able research workers in psychology would be utilized to the best advantage. It is to be hoped that the Select Committee will be able to turn its attention to these wider applications of psychology.

HIGH POLYMERS

Collected Papers of Wallace Hume Carothers on High Polymeric Substances
Edited by Prof. H. Mark and G. Stafford Whitby. (High Polymers, Vol. 1.) Pp. xix+459. (New York: Interscience Publishers, Inc.; London: H. K. Lewis and Co., Ltd., 1940). 8.50 dollars; 51s. net.

Physical Chemistry of High Polymeric Systems
By Prof. H. Mark. Translated from the manuscript by K. Sinclair, revised by J. Edmund Woods. (High Polymers, Vol. 2.) Pp. x+345. (New York: Interscience Publishers, Inc.; London: H. K. Lewis and Co., Ltd., 1940.) 6.50 dollars; 39s. net.

IT is impossible for one author to attempt to bring within the compass of one or even a series of volumes a comprehensive and authoritative account of high polymer systems. Nothing less than a carefully chosen team of experts will suffice for the task. While the subject has come more and more into prominence in recent years this is only partly due to new knowledge of synthetic polymers, for there has accumulated over a considerable period an extensive and often unco-ordinated body of knowledge of the natural high polymers, rubber, cellulose, proteins and the like. Gradually, however, the whole subject has been cleared of indefinite opinions and conceptions, and some degree of order introduced into this branch of chemistry. This does not mean that all the fundamental problems are solved, and it is now only a question of settling matters of insignificant detail. Much has yet to be done, and a first step in the process is a clear survey of the existing state of affairs. This is the object of the editors—R. F. Burk, H. Mark and G. S. Whitby—in the volumes under review.

Appropriately enough the first volume of the series comprises the collected papers of the late W. H. Carothers. It is difficult to realize that in the short space of nine years Carothers not only contributed handsomely to the subject of polymers but also brought into being two well-known plastics of unique properties—'Nylon' and 'Duprene' (polychloroprene). In these collected papers we see the train of thought which led to the discovery of these substances. Their discovery was no idle shot in the dark or the outcome of a lucky experiment. It was the result of a most painstaking and systematic search at a time when intuition played a large part. In his first paper, Carothers clears the ground by considering in general the theory underlying the formation of condensation polymers; that is to say, it is an attempt to predict whether bifunctional molecules will react inter- or intramolecularly. On this basis an examination is made of those molecules which form polymers, but it is soon shown that the molecular weights of the products are rather low to be of interest from the plastic point of view. The matter is not left there, for it is realized that higher polymers may be formed only if the reaction is finally carried to completion in a molecular still. At this stage molecular weights of the order of 10,000 become a practical proposition, and thereby the prospect of obtaining synthetic fibres of sufficient strength immediately presents itself. Carothers carries the argument to a logical conclusion by taking two further steps. The first is the realization that lateral interaction between macromolecules is a prerequisite for mechanical strength. The second is that such macromolecules must be orientated side by side and parallel to the fibre axis. Both are achieved, one by resorting to the polyamide system and the other by successful cold drawing of spun fibres.

The search for a variety of rubber exempt from the disadvantages of the natural material proceeded in a similar logical fashion. Here, however, the basic substances, namely vinyl acetylene and divinyl acetylene, were available and the problem was to make from them a satisfactory rubber. Innumerable compounds of hydrochloric acid with these two reactive hydrocarbons were investigated, with the result that in so far as dienes are concerned we now have a much clearer picture of the general type of diene system likely to give rise to molecules of high enough molecular weight. The relationship between rubber-like properties and chemical constitution was not revealed by these researches. Another interesting line of work, upon which there is only one paper, is the synthesis of saturated hydrocarbons of high molecular weight up to $C_{90}H_{182}$. There are many other papers full of new ideas and suggestive side-lines of which mention cannot be made. They all go to show that, had Carothers been spared, he would have made even greater strides than in this decade of intense and fruitful activity.

The second volume in the series, by Prof. Mark, really is Vol. 1 of the systematic treatment of high polymeric substances. This is shown most clearly by the fact that there is very little about polymers except towards the end of the book. It is, however, necessary in a comprehensive treatise to describe in some detail the physico-chemical methods required to deal with the reactions and structure of high polymers. Certainly such a description may be found in a variety of monographs on physical chemistry. In this volume all that is necessary for an understanding of polymers is brought together conveniently and compactly. Enough is given of modern valence theory to form a good basis for the discussion of methods used for the determination of interatomic distances. There is especially a detailed description of X-ray methods as applied to crystalline and amorphous matter. Since the peculiar properties exhibited by high polymer systems are due to a very large extent to the character of intermolecular forces, there is a section dealing with this aspect of the problem.

Molecular weights of polymers are almost invariably determined by measuring the osmotic pressure or viscosity of solutions. Unlike solutions of small molecules, polymeric solutions behave in an anomalous manner, and thus the interpretation of measurements is still a source of intense and as yet inconclusive controversy. It is here that the subject needs exact treatment. Ultracentrifugal technique is not described in detail, but enough is given to indicate the potentialities of the tool.

The mechanism of polymerization, as revealed by kinetic studies, is briefly mentioned, but again lack of space prevents any thorough treatment of the topic. Much has had to be compressed into this volume, and it is a tribute to the author that the subject is presented so clearly and pleasantly. For those not specially interested in high polymers this volume gives an unusual approach to certain parts of physical chemistry not found in the normal text-books.

It is to be hoped that, in spite of difficult times, the editors will find it possible to complete the task of which the present volumes represent a very welcome beginning. H. W. MELVILLE.

MUSEUM EDUCATION FOR THE YOUNG

Youth in Museums

By Eleanor M. Moore. Pp. ix+115+12 plates. (Philadelphia: University of Pennsylvania Press; London: Oxford University Press, 1941.) 12*s*. net.

THIS volume gives a clear picture of the very important part taken by American museums in the education of children. The author received a generous grant from the Rockefeller Foundation which enabled her to visit 103 museums in the United States for the purpose of studying the work that is being done for children. She also visited museums at Vancouver and Toronto.

The history of the development of museum education for the young is not outlined, but the author remarks that the importance of youth in museum progress is a "comparatively recent realization". It may be recalled, however, that in the United States and also in England there were, even in the 'eighties, far-seeing museum educationists who fully realized the desirability of catering for youth. In 1887 the Horsfall Museum at Manchester was encouraging children's visits and lending pictures and objects to schools, and about that time Sir Jonathan Hutchinson was holding classes for the young in his Educational Museum at Haslemere, where, a few years later he held examinations for children which included the identification of objects and portraits.

By 1900 several of the larger American museums had established sections or galleries specially adapted to the comprehension of children, and prizes were offered for essays.

Gradually it dawned upon the American public that youth is "the life-blood of museums", and, when this was fully comprehended the formation of children's museums was developed with tremendous and characteristic energy. At the present time there are at least two thousand adult museums, and children's museums "are springing up everywhere almost overnight like mushrooms", but those founded without requisite knowledge and without public backing will either quickly pass out of existence, or, like many museums in small towns in the British Isles, struggle on though "doomed to stagnation and eventual extinction".

The successful ones, established with inspiration and foresight, are controlled either by boards of education or by individual schools. A few children's museums are controlled by their own boards, and yet others are a separate but distinct part of well-known adult museums.

A children's museum may be defined as one containing objects selected, exhibited and interpreted for children in a place set aside for children. The title has been subjected to criticism—variants are "Junior Museum", "Recreation Museum" and "Little Museum". There is only one American museum styled "educational"; its principal function is "the lending of large numbers of objects to the public schools of the city [St. Louis] at the request of teachers". Some people, doubtless with dismal recollections of the gloomy and dry-as-dust museums of fifty years ago, even hold that the word "museum" is a forbidding one "for any active modern concern, especially where the stress is laid on making children feel a home-like atmosphere". The reviewer's experience, however, is that if the activities are sufficiently attractive, boys and girls of all ages do not give up their allegiance to the local museum.

The author points out that to-day most adult museums welcome the interest of children and do everything to encourage it. The following quotation conveys a vivid impression of the result of such encouragement in certain museums.

"The Toledo Museum of Art has been a veritable Pied Piper until on Saturdays traffic is almost held up by the vast hordes of children arriving for classes. The Art Gallery of Toronto has days when it is almost impossible to walk around the galleries for the children sketching and the various activities in the Cleveland Art Museum crowd the galleries in the same way. The University Museum in Philadelphia looks forward to the yearly visit of hundreds of small boys from a certain school who for years have stretched out on their stomachs on the floors whenever the spirit moves them to enjoy and record better the impressions of their visit in picture form. The Seattle Art Museum and the Newark Museum point out with pride the stone camels continually kept polished by children riding them, and Venus' knee, so shiny and dirty from small hands caressing it every time children pass. These do not point to the fact that children are not wanted or that they cannot be made to feel at home. Many an adult instead of being annoyed is seen to smile at their unconcern over adult intrusion."

Allusion is made to the falling off in museum attendance of high-school boys and girls. It probably results from lack of time as much as from the absorption of new interests. In some places children's clubs have been established in direct connexion with the museum, and the members make expeditions to collect not only flowers and insects but also minerals and fossils—a sound plan which, if adopted in Great Britain, might revivify some of the languishing rural museums.

The author very rightly insists that "No matter how small its beginnings the first thought in the minds of those organizing children's museums must be the setting up of standards. No matter how slowly or how fast the enterprise takes hold those same standards must be upheld to the end to insure the right to assume the name of museum."

We are assured that "from all directions come requests for more publications and of a different type from the usual technical bulletins which most museums offer the public". The demand is met in various ways: for example the Buffalo Museum of Science prints for free distribution coloured game cards, approximately 5 in. × 7 in., with the game—it concerns exhibits in the museum—on one side and an invitation to visit on the other. The Cincinnati Museum of Natural History issues a miscellaneous publication of 330 facts and questions chosen at random to direct attention to the Museum. Here are two of the questions: "Do you know that a single oyster eats 72,000,000 organisms in one day?" "Do you know that snakes walk on the end of their ribs ?"

The great value of practical demonstrations is stressed, for such are always popular. "An individual who can actually show how to spin or weave, throw clay on a potter's wheel, paint a picture, stuff a bird, or make a plaster cast always draws a crowd—the act of doing is indeed dramatic."

This very interesting outline of museum doings for youth concludes with the anticipation that the young people's museum of the future will be "A museum whose interests will be entirely interwoven with every facility and every concern of the community, but one whose identity and influence will remain distinct".

BIOCHEMISTRY TO-DAY

An Introduction to Biochemistry
By Dr. William Robert Fearon. Second edition. Pp. xii+475. (London: William Heinemann (Medical Books) Ltd., 1940.) 17*s.* 6*d.* net.

THE new edition of Dr. Fearon's book is very welcome, for, since the first edition in 1934, much that is of profound significance in biochemistry has taken place, and the new edition shows every evidence of careful and up-to-date revision. Some of the chapters might almost be described as miniature monographs, so admirably does the author summarize the essential facts of his subjects. It is perhaps a little invidious to single out individual chapters for special mention, when all are of uniformly high quality, but those on enzymes, hormones and proteins are particularly informative. The book contains little that is non-essential, and the usual discussion of the elementary principles of physical and organic chemistry is fortunately omitted. On the other hand, there is a great deal in the book that one might not have expected to find in a so-called "Introduction", material that up to the present has only been available in the original literature or in occasional reviews.

The book is unorthodox in many ways. For example, the second chapter discusses the "Biological Elements", and the third "Inorganic Compounds", subjects that are usually and quite improperly ignored. The justification for beginning with the inorganic constituents of living matter—the "shovelful of clay"—is doubtless contained in the apt quotation from George Russell which heads Chapter 2. In later chapters, the substances with which the dry bones are clothed—the carbohydrates, proteins, lipides, and other essential constituents of the body—are discussed, together with their functions.

The quotations with which the book is seasoned form another unorthodox feature. These range from Swinburne to Chesterton, from Shaw to Tobit, the last being a particularly apposite reference. The biochemists of Dublin seem to share in the literary atmosphere of that city!

The chapter on hormones is also unconventional, first, by reason of the fact that the old name 'autocoids' has been resurrected and, secondly, because a wider range of factors than usual comes in for consideration by reason of the extended definition. Though Dr. Fearon has perhaps not quite played the game in adopting this artifice, one is glad he has done so, for the result is one of the best chapters in the book.

Unfortunately, the book is not entirely free from errors, mostly small and unimportant, though a few are of more moment. Thus the formula given for α-carotene on p. 202 is erroneous; as to a less extent is that of *iso*alloxazine on p. 206; the statement on p. 246 that vitamin D is found in the leafy part of most plants is clearly wrong, and is in fact corrected on the next page but one; and surely the identity of the vitamin D of fish liver oils with that produced by irradiation of 7-dehydrocholesterol, as established by the brilliant work of Brockmann and his colleagues, is of sufficient importance to deserve mention. A major error, or series of errors, occurs in the list of references on p. 265, where "J. Nutrition" should read "Nutrition Abstracts and Reviews" in all three instances. Another unfortunate but understandable mistake is the inclusion on p. 136 of Kogl and Erxleben's claim to have found *d*-glutamic acid in tumour tissue protein. It is to be hoped that this statement, recently proved wrong by several groups of workers, will be deleted in the next edition. Slips such as these can readily be excused when one considers the wide field that the author has covered, and the heroic struggle he must have had to bring each subject up to date.

All chemists, biologists and clinical workers will profit by a study of this book, and those whose work lies in the biochemical field will find much that is stimulating. Here we are enabled to obtain a comprehensive picture of the rapid expansion that has occurred within recent years, and those with imagination will see hints of the problems that remain to be investigated. What, for example, happens to the energy produced in the brain, "silent and motionless", by the consumption of 0·14 ml. of oxygen per gram of tissue per minute? Does the theory of energy-levels recently advanced by Szent-Györgyi supply the answer? Why does the *in vivo* oxidation of fatty acids occur at the α-carbon atom, when every organic chemist knows that the β-carbon atom is the more reactive? Is the recent observation of Kharasch that the β-carbon atom is more reactive than the α-atom in presence of peroxide or light relevant to these facts? What, if any, is the significance of the occurrence of β-alanine in pantothenic acid on one hand, and in carnosine and anserine on the other? These and like questions that spring to mind will doubtless be answered in due course. In the meantime, we are probably on the eve of further striking developments, and we must hope that the new knowledge thus gained will find its place in the next edition of Dr. Fearon's admirable volume.

F. A. ROBINSON.

The Boy Electrician

Practical Plans for Electrical Apparatus for Work and Play, with an Explanation of the Principles of Everyday Electricity. By Alfred P. Morgan. Fifth edition, revised by J. W. Sims. Pp. 328+11 plates. (London, Bombay and Sydney: George G. Harrap and Co., Ltd., 1941.) 6*s*. net.

IN some quarters the die-hard tradition still lives fully up to its name and in that austere domain this volume would, no doubt, be classed and discussed as just "another of those popular books for the scientifically immature and curious". Such a label, however, would betray nothing but a complete lack of understanding of the times and of sympathy with the aspirations of adolescence. The present book is, in its way, as important to those to whom it is addressed as is many an advanced work to the established scientific or technological worker—maybe even more so in its possible influence in the formative years of youth; because of this we are glad to see the new edition.

The scope of the work is wide and, in parts, a little beyond the capabilities of the average boy experimenter who, for example, will have to advance quite a considerable way with serious studies before he understands the chapters on transmission and on A.C. circuits. No harm is done, however, by introducing these subjects, for they are subordinated to the main issue.

More particularly, the book covers magnets and magnetism, static electricity and machines, cells and batteries, electromagnetism, measuring instruments, telegraphs and telephones, induction coils, electric transmission, transformers, A.C. generators and motors, radio, electric railways, lighting, A.C. circuits, and gas-discharge tubes. The experiments and apparatus devised are such as any boy can carry out and make for himself.

The book is one of a series planned for boys with a craving for investigation, and it serves its purpose well.

S. A. S.

An Outline of Metallurgical Practice

By Prof. Carle R. Hayward. Second edition. Pp. xi+690. (London: Chapman and Hall, Ltd., 1941.) 38*s*. net.

THIS work is intended to serve as a reference book for engineers and also to assist students who are approaching the study of metals without previous practical experience. The first object is excellently fulfilled, it being understood that the term metallurgy is used in a restricted sense, to cover only processes of extraction and refining, and that it is almost entirely confined to American practice, although statistical tables of world production are included. Some previous knowledge is required of the reader, as many of the terms are not defined, and the 400 illustrations are not all self-explanatory. Thus there are several references to the Cottrell treater for dusts, but the fact that this is an electrostatic device is not mentioned. The most valuable feature is the description, under each metal in succession, of typical plants and processes, with drawings and photographs. Unlike many text-books covering similar ground, some of which have passed through many editions, the book is not burdened with accounts of obsolete processes.

Here and there, as in the section on magnesium, the lack of reference to European practice involves the omission of processes which are being used successfully, but on the whole the information is full and recent. In dealing with alloys and some smelting processes equilibrium diagrams and photomicrographs are given, without reference to them in the text, but their inclusion is stated to be deliberate, and to be intended for students who have already followed a course in metallography. As no part of the discussion is based on them, the technical reader without such knowledge is not confused.

Each chapter concludes with a table of the principal properties of the pure metal, and where these have been checked they have been found accurate, although it is not enough at the present day to record hardness only on the Mohs scale. The book is well produced, but the large type employed makes it rather bulky.

C. H. D.

The Fauna of British India

Including the Remainder of the Oriental Region. (Published under the patronage of the Secretary of State for India in Council.) Edited by Lt.-Col. R. B. S. Sewell. Diptera. Vol. 6: Family Calliphoridæ. By R. Senior White, Daphne Aubertin and Dr. John Smart. Pp. xiii+288. (London: Taylor and Francis, Ltd., 1940.) 18*s*.

THIS latest addition to "The Fauna of British India" series deals with a group of considerable economic importance, since it comprises those creatures known as 'blow-flies'. At the same time it is concerned with a group greatly needing thorough study. The authors regard the Calliphoridæ as forming a family separate from the Tachinidæ, to which they are closely related. They deal very fully with the external morphology of its members and include in the account a useful illustrated description of the male genitalia, which are of pre-eminent importance for the separation of the different species. While the primary object of their work is taxonomic, the authors give indications regarding the biology of the various species wherever anything at all is known on the subject. Notwithstanding the unpleasant habits of most of their members, the Calliphoridæ are a group of very definite biological interest owing to the diversity of larval and adult habits and the great range of coloration displayed by the flies.

We can recommend this volume as an admirable introduction to the study of the Calliphorids not only of India but of other tropical lands also. The fact that it only deals with what must be a very small proportion of the fauna of these insects will, it is hoped, induce resident Indian entomologists to collect and observe them with more interest than has been shown in the past.

A. D. I.

SCIENCE AND GOVERNMENT

THE future of the relations between science and government formed the basis of several contributions at the Conference on Science and World Order organized by the Division for the Social and International Relations of Science of the British Association and held in London during September 26–28.

Sir Richard Gregory, president of the British Association, in opening the session, pointed out that men of science can no longer remain indifferent to the uses to which the powers created by their researches are put. They have the right and the responsibility to ensure that the fruits of their discoveries are not left entirely at the disposal of agencies which do not understand their nature or which misuse their promise.

Dr. J. Negrin, formerly professor of physiology in the University of Madrid, and lately head of the Spanish Republican Government, maintained that recovery, reconstruction and the laying of foundations for a lasting peace will depend fundamentally on a successful union between statesmanship and science. No less on this union depends the attainment of the immediate objective of victory in the present conflict, a victory without which our plans will be in vain. Between the statesman and science a dual relation is possible: a passive one, wherein the statesman incorporates learning, assimilates the scientific method, and becomes imbued with the scientific spirit; and an active one wherein he makes use of the teaching and progress of science.

The relation between science and government in Great Britain was discussed by Viscount Samuel. A year ago our resources of scientific knowledge and ability were still being very insufficiently used. Of late there has been a marked advance as seen in Lord Hankey's answer to a question in the House of Lords, in which he gave a full account of the numerous research bodies and advisory committees which serve as a link between scientific men and Government departments (see NATURE, April 12, p. 432).

According to Prof. A. V. Hill, Foulerton professor of the Royal Society, there are Government establishments in which the spirit is a hundred per cent right; there are others in which it is miserably wrong. In the research establishments of the Ministry of Supply, the Scientific Advisory Council and its numerous committees, chiefly composed of independent men of science (including engineers), exert a considerable and beneficial influence. The Admiralty, on the other hand, with its traditional devotion to secrecy, has always resisted any suggestion that an advisory council containing independent men of science should be set up to take an interest in its research. In the Air Ministry and now in the Ministry of Aircraft Production the conditions are intermediate.

It is not necessary—indeed it would be absurd—to ask that an organization of the magnitude of the Scientific Advisory Council of the Ministry of Supply should be set up in every department; but a panel of two or three independent advisers at least is necessary if opportunities are not to be missed. It is essential, if the scientific minds of workers in Government employment are to be saved from sterility, and their souls perhaps from damnation, that there should be as little distinction as possible between them and those in the universities, in industry, and in other independent institutions. In Great Britain we do not believe in bureaucracy. Our national genius has evolved a system by which the activities of officials are continually subject to the advice and help and criticism of public-spirited citizens.

Prof. J. B. S. Haldane, professor of biometry in University College, London, compared conditions in Great Britain with those of the U.S.S.R. He pointed out that in Great Britain the distinction between the pure or academic scientist and his industrial colleague is fairly sharp. In the Soviet Union the gap is bridged in several ways. The same man or woman may work in an industrial laboratory and in one devoted to 'pure' research or teaching. Laboratories engaged in 'pure' research are occasionally assigned certain technical problems.

To prevent the formation of a bureaucracy, the Soviet system is resorted to. The workers in laboratories, including technicians, frequently meet to discuss its problems. In this way centralization from above is balanced by initiative from below.

As Prof. Hill pointed out, there are several ways of ensuring that the initiative and keenness of Government-employed men of science do not become blunted. One may encourage junior and senior workers alike to interchange freely with other departments, with industrial laboratories, or with universities; one may provide facilities for visiting workers, for coloquia and discussion meetings, and for attendance at meetings of learned societies; one may adopt a system analogous to that of the reserve of officers and other ranks by which the Fighting Services prepare for times of emergency. Many of the ablest workers elsewhere would rightly value a period of service in Government laboratories. The plan for a reserve of officers and for frequent and regular interchange between different kinds of institutions need not be limited to science ; it should be open to the Government service as a whole.

Mr. D. P. Riley, of the University of Oxford, speaking on the world planning of scientific research, put forward an eloquent plea for a greater share for the younger men of science in the counsels of scientific planning—a plea which it is hoped will receive sympathetic consideration. He suggested that as an essential supplement to present official plans, we put into direct contact with each other rank-and-file men of science in similar fields of science but working in different countries.

The past shortcomings of British colonial policy were discussed by Lord Hailey, who made several important suggestions for future consideration. It is advisable that the facilities afforded by all great imperial institutions of research should be utilized to the fullest extent and that the energies of colonial research workers should be strictly limited to problems requiring local inquiry. As Dr. Wilder Penfield, president of the Royal College of Physicians and Surgeons of Canada pointed out, if the universities of the United States and the Dominions were kept fully informed on all problems, they might well take up the torch of practical research.

The application of scientific organization to a department of State can be divided into five interlinked stages, according to Prof. J. D. Bernal, professor of physics in Birkbeck College. These are : (*a*) Information, where modern investigation, sampling and statistical methods are used to find the nature and extent of the needs to be satisfied : from this, by analysis, problems can be formulated. (*b*) Research, where the best answers to these problems can be arrived at. This involves a definite programme of work of every grade ranging from fundamental to *ad hoc* research, and good coordination between the different branches. (*c*) Development, where the solutions found are worked up into a state in which they can be used in practice. (*d*) Execution, or the putting of the plan into operation. (*e*) Control or the checking of the results by new statistical methods. This is a function of a control organization working in close conjunction with the information service.

The need for closer collaboration between Government design departments and people with production experience was emphasized by Dr. J. E. D. Swann, of the Association of Scientific Workers. Technical men on production or engaged on the development of Government designs frequently comment on the unsuitability of such designs for mass production. The necessity for changes is most appreciated by the younger men of science. Older men may dream dreams ; but the younger men see visions of the immense possibilities inherent in science, and they must use this vision to remove the encumbrance of outworn traditions, to sweep aside the hindrances of selfish individualism, and to develop new methods of collaboration and planning. But as Prof. Hill said, if science becomes tied to emotion, to propaganda, to advertisement, to particular social or economic theories, it may cease altogether to have its general appeal, and its political immunity will be lost.

That emotion and intelligence, united in a common objective, obtain astounding results in thought, in action and in conduct was rightly claimed by Mrs. S. Neville-Rolfe, of the British Social Hygiene Council, who also pleaded for a fuller appreciation and utilization of youth in helping to muster the forces of evolution and directing them to the development of man.

There is an overwhelming need for collating, interpreting and applying the various discoveries and concepts in biology, psychology, physiology, anthropology and sociology—branches of knowledge so pitifully ignored by communities and governments. The science of social biology is scarcely recognized at present ; but it is one which will need to be incorporated in whatever form the policy of world reconstruction and re-planning takes after the War. In fact, the main problems of social biology are immediate, though they may take a rather modified form during the War.

As Prof. Hill stated, the deliberate application of science in government is a new method ; it has never been properly or whole-heartedly tried. If it is to have a chance of success now, it must be saved from the start from sloppy thinking, careless handling or unscrupulous use. Nevertheless, Dr. Negrin stated that in periods of transition and readjustment, such as the present, science provides the statesman with a means by which he can discriminate the noxious from the sound. It provides the touchstone to reveal the senescence of traditions and to point out those which should be removed. Science can help the statesman to remove antagonism in social life and contradictions in individual conduct and collective behaviour ; also to correct professional deformations in the statesman himself, by maintaining a balance in his qualities.

It is the duty of science to share actively in the search for remedies. Viscount Samuel pointed this out and added that religion and philosophy are engaged in the same quest. Only when all three recognize that they are interdependent and move together in search of the common goal will the problems of our troubled age approach their solution.

From the above contributions alone, it is seen that the commonwealth of science is a true democracy, and must, therefore, take its right place in the counsels of the world for re-planning democracy when the time comes.

SCIENCE AND THE WORLD MIND

ALTHOUGH no thorough analysis of the concept of world mind was attempted at the Conference on Science and World Order, certain aspects of human consciousness were emphasized and many interesting avenues for further investigation were opened.

Mr. H. G. Wells issued the challenging statement that there is no orderly world mind as yet but only a world dementia, a gabble of unheeded and inconsecutive utterances, and that it is the business of scientific men to prepare a working conception of organized will and knowledge upon which mankind can go.

For man as a social being, the essential thing is that he stands at the growing point of a vast evolutionary process the characteristics of which we can see pretty well, according to Dr. J. Needham of the University of Cambridge. The march of living organization, the progress of the world mind, will not stand still where it is to-day. For us, at the middle point of time, the first duty is to appraise the social forces at work around us, to see in what direction they are leading: Which of them make for higher social organization, greater human unity, community and solidarity? This is the point from which we should approach traditional systems of morality.

Science is man's consciousness, his collective property of knowledge about the world in which he lives, according to Prof. Max Born, of the University of Edinburgh. For practical purposes we all agree about the direction which we wish it to take: peaceful co-operation, a maximum of freedom for the individual combined with the optimum of organized efficiency in production, economic and political security as formulated in the Atlantic Charter.

Mr. Wells stressed the fact that conditions of human life have changed so fundamentally during the last forty years that *Homo sapiens* cannot go on living as he has been doing during the past few score thousands of years. If he fails to adapt himself to the new conditions he will degenerate or perish altogether.

Aviation, radio and other means of communication have abolished distance. A stupendous increase in the power of realizing and utilizing material energy has reduced the need for unskilled labour and has led to technological unemployment.

States and communities to-day are biologically different organisms from what they were a few hundred years ago. The average age and literacy are greater; new factors—advertising and propaganda, mass production and selling—have crept in. If there is to be peace on earth henceforth, there must be a federal control of the air and of the material of international transport; of the conservation of world resources, and a declaration of human rights that will ensure for everyone a fair participation in the world's resources and a responsible ownership in our planet.

Immediate steps should be taken towards the development of a world mind: a world language with suitable spelling and phonetics and words that do not change their meaning according to circumstances and are not easily misunderstood. Finally a world-wide memory—a world encyclopædia—or better a world institute of thought and knowledge.

On the question of a world language, Mr. Wells, while highly critical of English as it now stands, considers that some slightly modified form of Basic English, with simplified spelling, might well form the basis for an international language. Prof. L. Hogben, who stated that four hundred international universal languages have been put forward since the seventeenth century, considers that Basic English possesses many of the necessary qualifications for an international language; but he is doubtful about using any of the current languages as a basis because of the prejudices associated with them.

In the matter of spelling Mr. Wells quoted Mr. G. B. Shaw as saying that about forty-one characters are needed to cover world needs.

The institute of thought and knowledge, the world-wide memory organization for the world mind, must have ready access to all the world's learning and thinking. It would include all the museums, galleries, libraries, atlases, surveys and muniment rooms in the world. Much has been done in the matter of documentation to bring together materials from a great number of countries, and the method of microphotography developed by Dr. Kenneth Mees and Mr. Watson Davis of Science Service, Washington, enables the contents of a whole library to be condensed in a small box. In addition we need for the workroom of the world mind general and particular digests, prepared by hundreds of thousands of workers continually bringing up to date and replanning the general and particular summaries.

Mr. Wells sees in the British Association, and particularly in the Division for the Social and International Relations of Science, and in kindred associations throughout the world, the making of a great international organism for pooling the scatterbrain world into a sane effective mentality.

Through the British Association the specialist can teach and learn and yet remain human.

A proper development of the world mind can only be achieved by a correct education of the young and the re-education of the adult mind to appreciate the full significance of the developments of science. In addition, as Prof. Born pointed out, if science is to be taught in a way appropriate to its place in the world order there must exist a clear idea of the order. This is a question of economics and politics guided by principles of philosophy and religion. The two extreme and opposing theories of dialectical materialism and individualistic idealism need not be irreconcilable any more than the two theories of light, the corpuscular and wave theories, to which Bohr's principle has supplied a solution, namely that waves and particles are limiting cases suitable for the description of particular aspects of the phenomena, two different languages telling the same tale, not contradictory but complementary. We cannot eliminate from human affairs either the collective or the individualistic aspects any more than we can deal with radiation without using notions both of particles and waves. We have to reconcile the individualist with planning, which is unavoidable, and the socialist with freedom of research, which is imperative.

Dealing with the curriculum of schools, Mr. J. A. Lauwerys, of the University of London Institute of Education, stated that much of it has been inherited from a pre-scientific age and that great changes are urgently needed. We must make sure that the material presented during the lessons is relevant to the needs and the conditions of twentieth-century industrial society. A curriculum planned around natural science and social studies is required. To this end a study of the history of science and technology, such as the eight million dollar research into curriculum needs, carried out over the last ten years in the United States, is enormously valuable. Science will cease then to be a specialized study and will help to explain social organization and get people used to thinking in terms of human welfare.

Mr. J. G. Crowther, of the British Council, dealt with the education of the adult mind. In his view contemporary automatism—repetition of the same errors by nations with different forms of governments—is due to a lack of adaptation of social forms to the possibilities of technique and can only be remedied by the scientific education of the general public.

Dr. Julian Huxley, in a paper circulated under the title of "Scientific View of Education as a Social Function", likewise advocates a proper education of the parents as a prime essential. He considers this necessary in order that they should not encourage and intensify the normal infantile repressions in the child. The persistence of such repressions into adult life has several disadvantages, notably the immobilizing of a considerable amount of so-called mental energy, deadlocked between the repressing and the repressed impulses.

Thus, in one sense, the most important single task of education is not an intellectual, but a moral and emotional one, the substitution of conscious, in place of unconscious, repression in the light of tolerance and reason.

The education of the emotional aspect of personality was even more strongly emphasized by Mrs. S. Neville-Rolfe. Every educational system, she stated, has concentrated on the training of intelligence, none has yet taken cognizance of the paramount influence of the emotional condition of man or his behaviour, or attempted to apply even our present knowledge of psychology, etc. (see p. 425). A true democracy can only be created by those who are emotionally and intellectually developed, inspired with a positive purpose in life. The emotionally immature belonging to a previous generation, are not qualified to govern or to lead youth in the present world crisis. The young to-day have a deep sense of spiritual values. They can appreciate the opportunity and accept the responsibility of mastering the forces of evolution and direct them to the development of man.

The Conference scarcely touched upon the problem of how to obtain agreement and unity of action among scientific workers, a point raised by Mr. Wells in his opening remarks. All those who have followed the deliberations of groups of highly intelligent men and women, from the League of Nations Committee for International Intellectual Co-operation onwards, cannot have failed to appreciate the difficulty of obtaining a result commensurate with the great abilities of those represented on such committees.

It seems well worth while investigating how to bring about the necessary unity of feeling, and to arouse sufficient enthusiasm among people agreed intellectually upon the work to be done in order to enable them to pull together as a team. Co-opting more of the younger men in the counsels of science will undoubtedly help much towards this badly needed unity. At present some of the more progressive men of science feel keenly the neglect of their services, especially when older authorities are complaining of having too much to do, too many committees to attend, etc. Once this feeling almost of frustration is eliminated, and younger men are given their rightful place in the advancement of science, a closer unity of feeling will be established.

PHYSIOLOGY AND ECOLOGY OF CUTICLE COLOUR IN INSECTS

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SEVERAL papers have recently been published describing differences in the physiological properties of dark- and light-coloured cuticles of insects. Pryor[1], Fraenkel and Rudall[2], and others have shown that the darkening and hardening of the cuticle are one and the same process—a dehydration resulting from the formation of coloured compounds of protein and polyphenols. The darker the cuticle, the harder and drier it will be.

Mackenzie and Muller[3] have demonstrated that resistance to ultra-violet radiation, as measured by the survival-rate of individuals and the mutation-rate of their offspring, is greater in the wild type of *Drosophila melanogaster* than in its yellow mutants. Experiments by Buxton[4] on heat absorption indicate that dark insects become warmer than light ones when exposed to sunlight. These results suggest that the usual explanations of colour differences as protective mimicry and warning signs, which are reviewed in Cott's book, "Adaptive Coloration in Animals"[5], do not completely account for all the phenomena of insect coloration.

There appear to be five main differences in the physiological properties of dark and light insect cuticles.

(1) A dark cuticle gives better protection against high-frequency radiations. (2) A dark cuticle absorbs radiant heat more readily; it also loses slightly more heat. (3) A dark cuticle is tougher and mechanically more resistant. (4) A dark cuticle is less easy to wet. (5) A dark cuticle gives better protection from desiccation.

An individual developing a dark cuticle must necessarily have a different metabolism from a light-coloured member of the same species.

It is not suggested that these differences apply in all cases. In some insects, though certainly not in many, the hardening and darkening processes may be independent. The physico-chemical processes resulting in hardening without darkening, or in darkening without hardening, can be presumed to differ from the processes investigated by Pryor and by Fraenkel and Rudall, and they are probably worth a separate investigation. Perhaps the findings of Hurst[6] on the behaviour of the cuticle towards apolar substances may have a bearing on this problem. Again, metallic colours are usually the combined effect of dark chitin and a special surface structure. Such iridescent structures, while having most of the physiological properties of dark cuticles, will behave like light-coloured objects so far as absorption of heat is concerned. Dark coloration that is not localized in the cuticle, as in the scales of Lepidoptera and the subcuticles of hemimetabola such as stick insects and dragonfly larvæ, will also not necessarily confer the physiological properties listed above. But after full allowance is made for these exceptions, the new findings allow of the formulation of a number of new general rules, indicating new phenomena and giving the first satisfactory explanation of several facts already established. These rules may be listed and classified as follows.

A. PROTECTION FROM LIGHT

Rule 1. *Of two related forms, the one more exposed to ultra-violet radiation will be the darker.*

For example, melanic forms of insects are found at high altitudes, while those the habitat of which is shaded from light are pale in colour. The pale insects living in caves and under bark and stones die easily when exposed to sunlight. This is reported for Campodea by Handlirsch[7]. Aquatic larvæ such as those of Corethra, which live at a considerable depth and are screened by the water, are colourless, while other mosquito larvæ which live near the surface are dark.

B. ABSORPTION FROM HEAT

Rule 2. *If the mode of life of an insect is such that heat absorption is advantageous, it will be dark; if it is irrelevant or disadvantageous, it may be pale.*

Lord Walsingham[8] first suggested in 1885 that dark insects absorb more heat than pale ones. This has been proved by Buxton[4]. It is not correct to assume, as Schröder[9] did in his "Wärme-Schutztracht-Theorie", that a high heat absorption is always advantageous. Buxton points out that it is obviously a disadvantage to black desert forms, the dark colour of which is explained by rule 12. The small snow insects, which are often dark, must absorb as much solar heat as they can, for their size prevents them from producing or retaining much internal heat. Insects in temperate climates, like butterflies and diurnal moths, which are active during the day, have a dark cuticle, and nocturnal moths a light one.

C. MECHANICAL STRENGTH

Rule 3. *Those parts of the insect body wall which are subject to great mechanical strain are usually dark.*

Examples include the dark mouth armature of many otherwise light larvæ; the dark colour of bee stings and many ovipositors; and the dark head and thorax of termites and other insects which are otherwise pale. The Ipidæ which mine under the bark of living trees are dark, whereas insects and larvæ living in decaying wood are usually white. In general, boring insects show only a dark armature and head, while burrowers like the mole cricket are entirely dark. The place of insertion of the muscles in beetles is frequently dark (Tower[10]).

Rule 4. *Giant forms are usually black; bright colours are more frequent among small insects.*

Rules 3–7 depend on the assumption that a dark cuticle is mechanically the stronger. This has not yet been directly proved. It is, however, a fact of common observation that the pale cuticle of the newly emerged imago is more easily deformed than the hard, darkened cuticle of the older insect.

Rule 5. *Hemimetabolic (heterometabolic) insects, before their last hatching, are rarely black.*

The cockroach is an example. A hard cuticle is difficult to moult, hence the exuviæ of hemimetabola are usually whitish or transparent, sometimes with dark mouth armatures and joints. It is also most likely that autotomy only occurs in hemimetabola as a hard cuticle would be difficult to break. It is interesting that very few Crustacea have a black cuticle; Crustacea continue to moult throughout life. There may be some exceptions among terrestrial forms like land crabs and land isopods.

Rule 6. *Heterometabolic adults are found in the same habitats as their larvæ, holometabolic insects rarely so.*

The persistence of a similar cuticle confines the hemimetabolic insects to a similar environment throughout life. A good illustration is the contrast between the white termites and the dark social Hymenoptera.

Rule 7. *Holometabolic larvæ are paler than their imagines.*

This also follows from the need to moult. Exceptions are to be expected where the larvæ need more protection against desiccation than the adult forms. The larvæ of many Carabidæ and Staphylinidæ, especially if they lead a predatory life, darken deeply after hatching and after every moult.

D. Water Repulsion

Rule 8. *The parts of the insect body where wetting must be avoided are frequently dark.*

For example, the tracheal ends of many metapneustic insect larvæ, living in a liquid or semi-liquid substratum (Drosophila, Eristalis, *Gastrus equi*). Many water beetles are black. Of course, wetting can also be avoided by other means, for example, hairs or oil smears.

E. Resistance to Desiccation

Following on the demonstration by Fraenkel and Rudall[2] that dark and light cuticles differ in water content; Kalmus[11] found differences in the resistance to desiccation of body colour mutants, of Drosophila. In *D. melanogaster* the dark mutants, ebony and black, lost less water and lived longer in a dry atmosphere than the wild type, whereas the light mutant, yellow, lost more moisture and died sooner. Yellow mutants of *D. simulans*, *D. pseudo-obscura* and *D. subobscura* were less resistant than their wild-type allelomorphs. A dark cuticle therefore appears to be a better protection against desiccation than a pale one. The fact that the proportion of water lost from the tracheæ and the body surface is still a matter of controversy does not greatly affect this deduction. Some water is certainly lost through the body wall, and the cuticular layers of the tracheæ are the same colour as the body. The implications of this deduction are of a highly complex but very interesting character.

In my opinion too much stress has been laid on macro-climatic data and on isolated determinations of temperature and humidity in considering the water needs of animals. Measurements of the micro-climate of an insect's environment, and even more direct investigation of its water supply and losses, will certainly lead to a better understanding of the adaptations and protective mechanisms of different species. Almost every insect gradually dries throughout its life, and in natural conditions very many insects die from desiccation before other causes intervene. Hence perhaps the statement of antique authors "Nihil inest". We may deduce from this that the longer the life period of an insect, the greater its need for protection from desiccation, leading to the following suggested rule.

Rule 9. *Long-lived insects are darker than their short-lived relatives.*

Extremely short-lived insects, such as some mayflies, are pale.

Rule 10. *Hibernating and æstivating insects are dark.*

This is not limited to imagines. The eggs of many Phasmodea which are dropped haphazard in the open and take a considerable time to hatch are dark and hard. The eggs of Tipulidæ laid in a similar manner are also dark, whereas the eggs of other Diptera which are deposited on a moist substratum are pale and soft. The triungulid larva of Meloe which hatches in spring is pale, while the triungulid larva of *Sitaris moralis* which hatches in autumn, and hibernates, is black.

Rule 11. *Most non-black insects are found in the tropics. Their related forms become darker as one approaches the poles.*

According to Van't Hoff, a fall in temperature of 10° C. doubles or trebles the life period; but evaporation is decreased by only about 40 per cent. Hence tropical forms need less protection from evaporation than forms living in cooler regions. Examples can be found in many insect groups. Sturtevant[12] has described this colour gradient in the Drosophilidæ of the New World. The Drosophilidæ of Japan, judging from the description and figures of Kikkawa and Peng[13] show the same correlation between colour and latitude. Alpatov[14] has found that the honey-bees of European Russia are larger and darker in the north than in the south. There is a gradient between the two forms, except in the Caucasus, where dark bees are found.

Rule 12. *Insects exposed to drought are dark.*

Some species of desert insects are conspicuously black, though most are the colour of the sand (Buxton[15]). It therefore seems that increased protection from drought can to some extent counterbalance the disadvantages of absorbing more heat (rule 2), and of being more conspicuous. The dark cuticle of many scorpions living in dry habitats may be explained on similar lines, although they are not insects. Where drought occurs without extreme heat, as on salt soil, larger proportions of the insects are black. Many insects flying in the hot sunshine, for example, metallic insects like dragonflies and beetles, combine a dark under-cuticle, which will protect them from drying, with a reflecting superstructure that will probably protect them from over-heating.

Rule 13. *Insects which ingest abundant liquid food are frequently pale.*

This is particularly true of parasites, such as most aphids, bugs and lice. Fleas are an exception. They not only migrate, but are exposed to greater mechanical danger by their mode of activity.

Rule 14. *Insects with a wide range of activities are darker than their relatives living in permanently moist conditions.*

Wide-ranging insects and predators are frequently darker than sedentary and phytophagous forms. Island insects and forms living in small communities in widely scattered biotopes, such as small puddles, where conditions may frequently become unfavourable, may be expected to be dark; for their survival depends on their ability to resist desiccation until they again find a favourable environment.

There must, of course, be metabolic differences between pale and melanic individuals of the same species, but our knowledge of them is very meagre. Graubard[16] was unable to demonstrate any differences in the tyrosinase content of the imagines of various body-colour mutants of Drosophila, though he was partially successful in showing differences in the larvæ. The mouth armature of Drosophila larvæ in mutants of lighter body colour are usually lighter than those of wild type larvæ (Brehme[17]). The industrial melanism of insects affords an interesting field of study. One explanation often put forward, mentioned in Wigglesworth's "Insect Physiology"[18], is that the melanism is a mechanism for fixing and neutralizing the toxic organic substances produced by industrial operations. But there are many alternative hypotheses. Thus Ford[19] believes that conspicuousness is not a great disadvantage in industrial districts, where there are few predators, thus allowing the black varieties, which he and other investigators describe as "hardier", to establish themselves in competition with the less noticeable but more delicate cryptic forms. A third hypothesis is that the contaminated food of the insects in industrial districts induces gene mutations producing melanism. A great deal of work is obviously needed before these questions can be decided.

Some cases are known in which the nature of the larval environment of the individual affects the body-colour of the imago. Thus lepidopteran larvæ subjected to increase of humidity or decrease of temperature usually produce darker imagines. This has little bearing on our problem, as in this order of insects coloration is due to pigment in the scales rather than in the body-wall proper. In the beetle *Leptinotarsa decemlineata*, individuals in which the white stripes were enlarged were produced from larvæ reared in moist air (Tower[20]). This fits in with the rules enunciated above. But other species of beetles and other insects react in the opposite way to changes in humidity. These reactions of the individual are not necessarily relevant to the problem of the adaptation of a species to special ecological conditions. It is generally agreed that characters acquired by the individual are not inherited. The important factors are mutation and selection. The rules already given show the ways in which selection may be expected to act. Mutations producing the colour changes that form the raw material for selection are known to occur in many insect species in Nature. Sometimes the genes reponsible for the darker forms are dominant, sometimes recessive. In Drosophila, as in many other species, it has been proved that great differences in body colour may result from the mutation of a single gene. Different alleles must have become fixed in the different species. In some cases, such as *D. melanogaster*, *D. simulans* and *D. montium*, rather light forms have become established as the normal, and both the very dark forms, like ebony and black, and the extremely light forms, like yellow and tan, are aberrant mutants. On the other hand, there are many dark Drosophila species where the colour mutants are all lighter than the normal

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type. Although body colour primarily depends on a very few genes, its stabilization in a species must be determined by many other genetical factors.

The fact that so many kinds of insects, probably the vast majority, are dark, might be put forward as an objection to the above rules. If dark colour is so widespread, why not treat it as the normal thing, instead of formulating rules to account for it in each particular case? But if this view is taken, it is still necessary to account for the existence and distribution of the light-coloured forms, which amounts to the same problem. Handlirsch[7] points out that most of the primitive types within the bigger and higher insect groups are dark. This fits in with the views on the functions of melanism here put forward, if it is assumed that the development of a supporting exoskeleton and the conquest of the air by these creatures is made possible only by heavy chitinization. But any specialization which leads to life in an environment where water supply is plentiful and great mechanical strength is not demanded will remove the necessity for dark coloration and allow the production of pale insects. On the other hand, the primitive orders of insects, the members of which have probably never strayed from a rather damp and sheltered environment, contain many pale forms which are only slightly resistant to desiccation, such as Campodea (Handlirsch[7]).

The rules suggested above will often appear contradictory when applied to the ecology of a given insect species. Some factors in its mode of life will call for dark coloration, others for paleness. The colour actually observed will then indicate what are the controlling factors in the ecology of the species. Take for example the colour gradient of related forms between tropical and colder regions. By rule 1, it would be expected that tropical forms, being more exposed to ultra-violet radiation, would be darker. The opposite is actually observed, showing that protection against evaporation, prescribed in rule 11, is the more important factor. In alpine insects, where increased ultra-violet is associated with decrease of temperature, the two factors operate in the same instead of in opposite directions, and dark colour increases with altitude. There is a similar conflict between the effects on the cuticle colour of increase of size. Because of the need for greater mechanical strength, large insects may be expected to be dark. On the other hand, small insects would seem to need more protection from desiccation, and hence have a darker cuticle than large forms. But the life period of small insects is generally shorter than that of their larger relatives, lessening their need for protection. So on balance it is among the small insects that the majority of non-black forms are found.

There are also numerous cases where several factors in the ecology of an insect act jointly in the direction of a dark (or pale) colour. The dark colour of alpine insects has already been mentioned. In the case of the tsetse fly, the dark colour may be put down to its relatively large size, its diurnal activity in a dry region, its wide range, scattered habitat, or its long life as an imago, all of which, according to our rules, favour pigmentation.

This interpretation of the physiology and ecology of dark chitin, based on its newly detected physical properties, is of course not intended to replace entirely all the conceptions about colour adaptation previously formulated. On the other hand, hypotheses about imitative coloration and the like cannot but gain in certainty and precision when the physical factors are also taken into full account. The groups of organisms the colour of which is not explicable by the above-mentioned consequences of the darkening-hardening process provide the most suitable material for the study of mimicry. Examples of this are the subcuticular colour patterns of aquatic larvæ or nymphs, for example of dragonflies; the wing patterns of Lepidoptera; the body coloration of hemimetabola. Physical and cryptic advantages might also conflict, as in the case of industrial melanism, if Ford's hypothesis is correct, and among the desert populations described by Buxton, consisting of imitative sand-coloured as well as drought-protected dark individuals.

It is hoped that the new rules and considerations suggested in this article will not only provide the entomologist with a new point of view in his endeavours to bring order into his subject, but that they will also be of more general interest. Insect coloration has always been a sort of testing-ground for the theory of evolution; and insects, after all, comprise the majority of all animal species.

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OBITUARIES

Mr. William Macnab, C.B.E.

BY the death of Mr. William Macnab, on September 2, at the ripe age of eighty-four, we have to record the loss of one who not only made original contributions to our knowledge of explosives, both as to their properties and manufacture, but who in addition must be considered as a pioneer in the recognition of the importance of chemical engineering in Great Britain.

Coming from Greenock, his father being a shipbuilder there, he took up the subject of sugar chemistry, after a training at the University of Glasgow, where he made a life-long friendship with Ramsay. Fond of travelling, he spent some time in Germany in connexion with sugar and later in Canada and the United States ; in Siberia also he passed an adventurous two years engaged in prospecting. He could converse readily in French, German and Russian.

About the age of thirty Macnab took up a consulting practice in partnership with C. Napier Hake and carried this on after his partner had left for Australia to become Inspector of Explosives for Victoria. It was at this period and in collaboration with Napier Hake that he undertook the translation and collation of Berthelot's papers on explosives, publishing in 1892 "Explosives and their Power", which is a handbook constantly referred to by all explosives chemists. This book describes the application of thermochemistry to explosives, gives Berthelot's calorimetric data for explosive reactions over a wide field and deals with many explosive phenomena.

At this time Macnab began his original contributions to the study of explosives, and with E. Ristori published researches on partially gelatinized and on fully gelatinized propellants (*Proc. Roy. Soc.*, 56, 8 ; 1894). A bomb of the Berthelot type was used ; heat values and volumes of gases given off with their composition were measured, together with the metamorphosis undergone by gelatinized mixtures of nitroglycerine with various nitrocelluloses when exploded in the bomb. This work had importance as well as accuracy, as was shown by the agreement of products with original composition of explosive. Pressures were measured in another bomb and these agreed with the values found by Sir A. Noble. Later (*Proc. Roy. Soc.*, 66, 221 ; 1900) the same authors described attempts to determine the temperature of explosion (apart from its calculation from heat values and specific heats) by a method depending on the use of thermocouples of gradually decreasing diameter, the deflexion of a galvanometer mirror being photographically recorded. Although absolute values for temperature were not obtained, the results placed different explosive mixtures in a comparative sequence. This subject was continued in collaboration with A. E. Leighton (*J. Soc. Chem. Ind.*, 23, 298 ; 1904) when the heat values were compared with the galvanometer throws, the order of the powders being broadly the same in both cases.

Always interested in chemical manufacture, Macnab played an important part during the War of 1914–18, when he became a technical adviser on Lord Moulton's staff, where full use was made of his experience in the manufacture, as well as knowledge of the properties, of explosives. Working in close conjunction with Kenneth B. Quinan he was intimately associated with the design of factories for high explosives and propellants, as well as with their administration when erected. Impressed by Quinan's method of holding monthly meetings of his factory staffs at which costs and efficiencies were minutely discussed, resulting in notable improvements in technique, Macnab undertook after the War the compilation of an important series entitled "Technical Records of Explosives Supply, 1915–1918" (H.M. Stationery Office), dealing with intermediates and finished explosives. These are valuable studies in which the chemical engineering aspect is emphasized, and serve as text-books for any school in that subject, for they include not only the theory of the processes, but also sketches of designs of plants, instructions for running them, calculations of heat-transfer and loss, and choice of materials of construction. They are so framed as to assist a student engaged in general chemical engineering problems, not necessarily those dealing with explosives.

This methodical approach appealed to Macnab, who lectured on the subject at University College, London, and led to his support in starting the Department of Chemical Engineering there. This movement was strongly urged by Quinan also who had felt the grievous lack of chemical engineers during the War of 1914–18. Some chemical achievements during this time were described by Macnab in his Hurter Memorial Lecture in 1922. For the same reason he acted as one of the founders of the Institution of Chemical Engineers, becoming its president in 1934, the William Macnab Medal of that Institution commemorating his name. Much of the success of the Seventh International Congress of Applied Chemistry in 1909 was due to him. For his work in the War he was made a C.B.E. in 1920.

Of striking appearance, suggesting robust health, with rosy cheeks and pointed beard, always dressed with perfect neatness, he will be remembered for his geniality and unselfish kindliness ; and his friends will remember the hospitality of his charming wife and himself at his house on the river, where it was his custom to entertain them, take them out in one of his craft, for he was a master sailor, and to some of them show his experiments in calorimetry with a large bomb that needed his athletic frame to manhandle. In his London house also, his skill at the piano and liking for good music will be remembered by many.

ROBERT ROBERTSON.

NEWS AND VIEWS

Foundation of a Nutrition Society

Workers engaged in research on nutrition in Great Britain have been feeling the need for a scientific society devoted specifically to their subject. In the past no organization has existed to enable investigators in the many and varied branches of the science—clinical, physiological, agricultural and sociological—to find a common meeting-ground for discussion and the exchange of views. Representative workers in all these fields accordingly decided recently to form a Nutrition Society. The new venture owes its conception to a circular letter signed by the following heads of some of the better-known centres for research on nutrition in Great Britain: Sir Joseph Barcroft, chairman, Food Investigation Board; Dr. Harriette Chick, head of the Division of Nutrition, Lister Institute; Prof. J. C. Drummond, scientific adviser to the Ministry of Food, and professor of biochemistry in University College, London; Dr. John Hammond, superintendent of the Animal Research Station, Cambridge; Dr. Leslie J. Harris, director of the Nutritional Laboratory, Cambridge; Sir Frederick Gowland Hopkins, professor of biochemistry in the University of Cambridge; Prof. H. D. Kay, director of the National Institute for Research in Dairying, Reading; Sir Charles J. Martin, formerly director of the Lister Institute of Preventive Medicine; Sir Edward Mellanby, secretary of the Medical Research Council; Sir John Orr, director of the Rowett Research Institute, Aberdeen; Prof. R. A. Peters, professor of biochemistry in the University of Oxford. Later a meeting was held at the Royal Institution attended by representatives from the various institutes, and the following provisional committee was formed: Sir John Orr (*chairman*); Dr. John Hammond (*vice-chairman*); Dr. Leslie Harris (*hon. secretary*); Mr. A. L. Bacharach (*hon. treasurer*); Dr. Harriette Chick, Dr. E. M. Cruickshank, Dr. H. H. Green, Prof. H. P. Himsworth, Prof. A. St. G. Huggett, Dr. Franklin Kidd, Dr. S. K. Kon, Dr. B. S. Platt and Dr. H. M. Sinclair.

It is, of course, not intended that the new Society should compete in any way with existing scientific societies; its functions would be complementary to theirs and would cover a more general and in some ways less specialized field. It is proposed that the main activity of the Society at the beginning should be to hold meetings at various research institutes, at each of which some specific topic should be discussed; several main papers would first be read and would be followed by a general discussion. Arrangements have been made to hold the first conference of this kind at Cambridge on October 18, when the theme will be "The Evaluation of Nutritional Status". Further particulars of the Society can be obtained from Dr. Leslie Harris, Dunn Nutritional Laboratory, Field Laboratories, Milton Road, Cambridge.

Food Values of Eggs and Cheese

Healthy and well-informed public criticism is good for all Governments, particularly when, as was the case in the House of Lords debate on September 30, it is constructive in nature. The debate dealt mainly with the Government food production policy, and a good case was made out for Government support to poultry keepers in their efforts to obtain maximum egg production consistent with the maximum production of crops suitable for direct use as human food. Viscount Dawson stressed the essential value of the egg as a constituent of human dietaries, not only for its use in preventive medicine, but also because of the unique part it plays with milk in maintaining the health and vitality of children and in keeping the active population well and fit in time of war. He maintained that it would be a mistake to penalize egg production in times such as these, and in this view was supported by Lord Phillimore, who hopes that further egg production will be encouraged. That the adoption of such a policy would be in the national interest is substantiated by an article in Nature of September 20, p. 335.

References were also made to the possible utilization of two protein-rich products for animal feeding. The first, a by-product in the production of acetone, has been proved to be of value as a protein concentrate in poultry-rearing mashes, and is characterized by containing not only protein in large amount, but also in addition appreciable quantities of riboflavin and lesser amounts of pantothenic acid. The second, a synthesized vegetable protein, appears to be 'fodder yeast', a product obtained by the fermentation of molasses and ammonium salts by means of *Torula edulis*. This material received the attention of the Royal Society in the War of 1914–18, and Temperton of the National Institute of Poultry Husbandry has shown that this 'fodder yeast' is a suitable substitute for fish meal in egg production rations.

A plea was also made during the debate for the encouragement of the production of ewe milk cheese. The contention that more human food would be produced by converting ewe milk into cheese than by producing mutton is undoubtedly correct; putting it into practice, however, is the difficulty, since it means setting up a new industry as well as introducing complications in the already difficult circumstances in which the arable or grassland sheep farmer is at present working. On technical considerations it is always possible to induce a change of Government policy, since the outsider may often be better informed than the technical advisers upon whose judgment the policy has been based. Criticism, based on quantitative considerations, although well-meaning, is almost always bound to fail, since the full knowledge of the position upon which the policy is based can only be known by the Government.

Dean of the Faculty of Medicine at Birmingham

Dr. A. Stanley Barnes has resigned his post as dean of the Faculty of Medicine in the University of Birmingham after ten years in office. Dr. Barnes, who was a student of Mason College, in addition to being closely associated with the local hospitals, attained an outstanding position as a consultant. About ten years ago he sacrificed his professional practice to become dean of the Faculty of Medicine, in which office he assisted in the planning and building of the City Hospitals Centre and the new Medical School of the University. He was a liberal donor to the building funds of the Medical School, and the perfection of the building and equipment reflects in many directions both his discriminating generosity and constant supervisory care. The Council of the University has recorded its grateful recognition of the valuable and devoted service which he has rendered to the University and to the cause of medical education in Birmingham generally.

Dr. Barnes is succeeded as dean by Dr. Leonard Gregory Parsons, professor of infant hygiene and diseases of children, who has been acting as deputy dean. Dr. Parsons, who was educated at King Edward's School, Aston, and the University of Birmingham, is physician to the United and Children's Hospitals, and was chairman of the Children's Hospital, an office which he resigned in January last, to become Midland Regional Hospital Officer to the Ministry of Health. During 1916–18, serving in the R.A.M.C., Dr. Parsons was officer in charge of the Medical Division 36th General Hospital, British Salonika Force, the Order of St. Sava of Serbia being conferred on him in 1917. He was vice-president of the International Congress of Pædiatrics at Stockholm in 1930 and president of the Children's Section of the Royal Society of Medicine during 1932–33.

Science and World Order

Speaking at a meeting convened by the Faculty of Science of Marx House on October 5, Prof. J. D. Bernal summed up the Conference on Science and World Order. The meeting, he said, tended to avoid reference to the difficulties of scientific planning at the present time. The first necessity is to win the War, and the time for planning is now. It is simple to see what we need from science, namely, an environment in which material things are at their best and have the ability to obtain a secure social life. Want and war are the two chief horrors of to-day. Science has pointed the way to remove them and will remove them if the peoples of the world co-operate with the scientific workers.

The attitude of complacency which existed in the higher scientific world is broken. Dissatisfaction is not confined to younger men of science but has reached the senior men. Dr. J. P. Lawrie, speaking at the same meeting, directed attention to the opposition displayed by high political personages when Prof. A. V. Hill organized a liaison between the men of science of Great Britain, the United States and Canada. He is of opinion that any plans made by men of science must secure the backing of the people before they can be put into effect by any Government. This means that men of science must thoroughly instruct the people, and this can best be done through the daily Press.

A Scientific Press Bureau

Mr. D. S. Evans, University Observatory, Oxford, writing with reference to the letter in Nature of September 27 by Mr. D. L. Johnston urging the need for a scientific press bureau, states that the Association of Scientific Workers has devoted considerable attention to this problem. A scheme has been drafted by the Association whereby each of its more than fifty branches all over Great Britain can act as centres of diffusion for simple and accurate facts on scientific problems of current importance, and it is hoped that this organization will begin functioning in a few weeks. It is an amateur organization, but its possibilities are considerable, and experience will be gained which will be invaluable if, and when, a more formal body is set up. Mr. Evans states that the Association intends to develop this propaganda work for science by every means in its power, and co-operation with other organizations or individuals will be heartily welcomed.

Point is given to the proposal by headlines which appeared in a recent issue of a well-known London evening newspaper. The headlines read "Anti-Gas Serum is Being Sent To Russia"; the accompanying letter-press indicates that the reference is actually to gas-gangrene serum. The mistake is understandable, but nevertheless emphasizes the need for scientific guidance.

Dr. Arthur Gamgee (1841–1909)

Dr. Arthur Gamgee, F.R.S., physiologist and consulting physician, was born at Florence on October 10, 1841, the son of a veterinary surgeon and pathologist. From the outset of his career he showed a special interest in physiology, particularly physiological chemistry, as was evidenced by his inaugural thesis at Edinburgh entitled "Contributions to the Chemistry and Physiology of Fœtal Nutrition". From 1863 until 1869 he was assistant to Dr. Maclagan, professor of medicine at Edinburgh, during which time he published several papers showing his outstanding ability to deal with abstruse physiological problems. In 1873 he was appointed the first Brackenbury professor of physiology at Owens College, now the University of Manchester. During the thirteen years he was there he took an active part in the work of the medical school, of which he was dean, and wrote numerous articles on physiology and pharmacology. He was also Fullerian professor of physiology at the Royal Institution during 1882–85, when he left Manchester. Eventually he moved to Cambridge, where he devoted himself to scientific research. Finally, he decided to live abroad and settled first at Lausanne and afterwards at Montreux.

Gamgee's chief publications were "A Text-book of the Physiological Chemistry of the Animal Body, including an Account of the Chemical Changes Occurring in Disease" (1880–1893) and "Physiology of Digestion"

(1893). He also translated Hermann's "Elements of Human Physiology" (1875). In 1902 he visited the United States by invitation to inspect the physiological laboratories there, and in the same year delivered the Croonian Lecture before the Royal Society on "Certain Chemical and Physiological Properties of Hæmoglobin". He died on March 29, 1909; a portrait and bibliography will be found in the *Lancet*, 1, 1141 (1909).

Sir Richard Thorne Thorne (1841-1899)

SIR RICHARD THORNE THORNE, F.R.S., a notable hygienist of the Victorian era, was born on October 13, 1841, at Leamington, Warwickshire, the son of a banker. He received his early education at Neuwied in Prussia and at a Paris *lycée*, and his medical training at St. Bartholomew's Hospital, where he qualified in 1863. Eventually he was elected physician to the Royal Hospital for Diseases of the Chest and to the London Fever Hospital, and about this time he was employed by the Medical Department of the Local Government Board to make various reports. He first became widely known by his work on quarantine and the international relations for the prevention of the spread of disease from one country to another. From 1885 onward he attended many international sanitary congresses as a representative of the British Government, and in 1892 he succeeded Sir George Buchanan as principal medical officer of the Local Government Board. The subjects in which he was most interested were diphtheria, on the natural history and prevention of which he delivered the Milroy Lectures before the Royal College of Physicians in 1891; tuberculosis, the administrative control of which formed the subject of his Harben Lectures in 1899, and the establishment of isolation hospitals for infectious diseases. He was elected a fellow of the Royal Society in 1890 and was also an honorary member of the Royal Academy of Medicine of Rome and a foreign associate of the French Society of Hygiene. His death took place suddenly on December 18, 1899.

Recent Earthquake

A SEVERE earthquake shook Quetta and the surrounding country in Baluchistan at 8.4 a.m. local time (2.34 a.m., G.M.T.) on September 29, 1941. The shock was also felt, though less distinctly, at Sibi, Mach, and Chaman, all in Baluchistan. The shock, which lasted according to human perception for thirty-five seconds at Quetta, was accompanied by heavy rumbling, and caused considerable apprehension. Although telephone and telegraph communications were temporarily dislocated, no serious damage or casualties are reported, and railways were unaffected. This lack of damage might easily be due to the thorough building of the new city after the calamitous earthquakes of May 31 and June 2, 1935. The re-planned city was built to earthquake-proof design according to the best building codes of California as worked out by seismologists and engineers. After-shocks to the 1941 earthquake took place at 2.35 a.m., 2.54 a.m., 4.34 a.m., 5.4 a.m. and 8 p.m. (all G.M.T.) on the same day. It will be recalled that Quetta was levelled to the ground on May 31, 1935, and that an area approximately a hundred miles in diameter was devastated. A severe aftershock occurred on June 2, 1935, and altogether there were about 40,000 casualties (NATURE, June 15, 1935, p. 986 and several subsequent numbers). Severe shocks also occurred near Quetta in September and October 1937.

On September 29 at just after 5 p.m. G.M.T. an earth tremor of some severity rattled crockery and moved furniture at Bethesda, a town of some five thousand inhabitants in Wales. The shock, which lasted according to human perception for about three seconds, did not cause any serious damage or casualties. Two earlier tremors of less intensity occurred early on the morning of September 27. Earth shakes, probably due to mining subsidences and minor fault slips, occur fairly frequently in Wales. One such happened at Pwllheli on December 12, 1940 (NATURE, Dec. 21, 1940, p. 803).

Announcements

M. MAISKY, the Soviet Ambassador, has been offered and has accepted honorary membership of the Athenæum.

THE title of Sir Ernest Cassel reader in commerce in the University of London has been conferred on Dr. Vera Anstey, in respect of the post held by her in the London School of Economics.

DR. FREDERIC JOHN NATTRASS, lecturer in therapeutics and clinical teacher in medicine in King's College, Newcastle-upon-Tyne (University of Durham) has been appointed professor of medicine in the College.

THE Minister without Portfolio has appointed an Inter-Departmental Committee, under the chairmanship of Lieutenant-Colonel Sir Francis Shelmerdine, director-general of civil aviation, to make recommendations as regards the reconstruction, organization and development of civil aviation after the War.

THE fourth Hinchley Memorial Lecture of the Institution of Chemical Engineers will be delivered by Sir Richard Gregory, who will speak on "Scientific Knowledge and Action". The address will be given in the Institution of Civil Engineers on October 24 at 2.30 p.m.

The autumn meeting of the National Academy of Sciences of the United States will be held at the University of Wisconsin during October 13–15.

PROF. W. E. S. TURNER, professor of glass technology in the University of Sheffield, will deliver a lecture before the London Section of the Society of Glass Technology on "Glass as a Substitute Material" on October 15 at 4.30. The meeting will be held at the Electric Lamp Manufacturers' Association, 2 Savoy Hill, London, W.C.2.

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. They cannot undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of NATURE. *No notice is taken of anonymous communications.*

Number of Primes and Probability Considerations

THE probability that a number chosen at random is divisible by p is $\frac{1}{p}$ and consequently that it is not so divisible is $1 - \frac{1}{p}$. On simple probability considerations, that is, provided that these probabilities are independent of one another, the chance that a number is simultaneously not divisible by a group of primes is therefore $\Pi\,(1 - \frac{1}{p})$. Hence the probability that a number in the neighbourhood of N^2 is prime should be $P(N^2) = \overset{p_N}{\Pi}\,(1 - \frac{1}{p})$ where p runs through the gamut of the primes from 2 to p_N the largest prime less than N. This product has the value $\frac{e^{-\gamma}}{\log p_N}$ where γ is Euler's constant.

If P is the probability of a number in a given region being prime, the number of primes in an interval Δ in this region must be on the average $\Delta.P$. Hence the number of primes in an interval Δ in the neighbourhood of N^2 should approach $\frac{\Delta}{e^{\gamma}}\,\frac{1}{\log p_N}$.

For large values of N, we may substitute $\log N$ for $\log p_N$, since the interval between successive primes is of the order $\log N$. Hence the number of primes in an interval Δ in the neighbourhood of N^2 should tend to $\frac{\Delta}{e^{\gamma}}\,\frac{1}{\log N}$. The correct answer, of course, is $\frac{\Delta}{2}\,\frac{1}{\log N}$, that is, about 11 per cent smaller.

It is curious that simple elementary probability considerations should give an answer so nearly right, but just failing by such a small fraction. It seems to imply that the probabilities are not strictly independent, that there is a slight tendency of factors to avoid one another; in other words, that after all the numbers in an interval divisible by $p_1, p_2, p_3 \ . \ . \ . \ p_l$ have been eliminated, the chance that one of the remaining numbers should be divisible by another prime p_m is rather greater than $\frac{1}{p_m}$.

Perhaps a reader of NATURE can throw light on this question.

CHERWELL.

Christ Church,
Oxford.
Sept. 13.

Effect of Negative Groups on Reactivity

RECENT experimental and theoretical studies of bond strength[1] have shown that our forecast[2], according to which in the series of gas reactions $Na + XR = NaX + R$ (X = halogen, $R = R_1, R_2$ . . .) the reactivity is inversely related to the bond strength C–X, holds true for hydrocarbon radicals R_1, R_2 . . . containing no negative groups. But the great acceleration caused by the presence of such negative groups (X_1, X_2 . . .) in reactions of the type $Na + XRX_1 = NaX + RX_1$ is as yet unexplained. The presence of these groups is not usually considered to weaken the bond strength C–X. In fact, it has been suggested by Pauling that, when X_1, X_2 . . . are halogen atoms attached to the same carbon as X, the strength of all the halogen bonds is rather increased than decreased by resonance[3]. Moreover, observations on the bond energy of acetyl iodide[1] failed to reveal any such weakening of the carbon halogen bond by the negative substituent (=O), which could explain that acetyl chloride reacts much faster with sodium vapour than does C_2H_5Cl [4].

A specific effect of negative substituents on reactivity can be deduced from the fact that in the presence of a negative substituent the transition state will resonate between three structures instead of the usual two. We shall have:

1. (*a*) $Na \ . \ . \ . \ XRX_1$
   (*b*) $Na^+X^- \ . \ . \ . \ RX_1$
   (*c*) $Na^+ \ . \ . \ . \ XR \ . \ . \ . \ X^-_1$

the component state *c* being due to the presence of the negative substituent X_1.

Take the case of a number of halogen atoms X, X_1, X_2 . . . in the molecule. A sodium atom approaching a polyhalogenated alkyl will interact simultaneously with each of the halogen atoms X, X_1, X_2 . . . in the sense of the transfer of an electron: $Na + \rangle C\langle - X \rightleftharpoons Na^+ \ . \ . \ . \ \rangle C\langle \ . \ . \ . \ X^-$ and likewise for $\rangle C\langle - X_1$, $\rangle C\langle - X_2$ . . . Each of these transfers may be considered as leading to an alternative final state, producing a different alkali halide molecule with the pairs of ions ($Na^+ \ . \ . \ . \ X^-$, $Na^+ \ . \ . \ . \ X^-_1$ . . .) separated by various distances. All these alternative final states will resonate jointly in any transition state arising in a reaction of a sodium atom with a polyhalogenated alkyl, and will depress the activation energy.

This resonance will increase steadily with the number of halogens X_1, X_2 . . . present in the molecule and also with their specific tendency to react with the sodium atom. The first part of this statement is patently confirmed by the observed cumulative accelerating effect which halogen atoms have on the reaction rate[4]; the second part may be analysed and tested as follows. Let us first think of all X's as being the same halogen, say, chlorine. The energy of the alternative transfer of the electron to the different Cl atoms increases with the electrostatic energy of the pair $Na^+ \ . \ . \ . \ Cl^-$, which is inversely proportional to the distance at which the halogen is situated from the Na atom at the moment of reaction, that is, in the transition state. Hence the reactivity of di-chloro compounds should increase with the mutual proximity of the two Cl atoms; and we should find, in particular, that *cis* di-chloro ethylene reacts faster than the *trans* isomer. All this has been confirmed by experience[4]. Moreover, the accelerating effect of halogen substitution should increase in the series F, Cl, Br, I, which represents the sequence in which the tendency to react with sodium increases; which also has been confirmed over a wide range of observations[4].

In the electron transfer discussed above the attachment of the electron to the halide molecule is clearly a manifestation of the *electron affinity* of the latter particle. The accelerating influence of a negative substituent on the reactivity of a molecule is thus seen to go parallel to the substituent's contribution to the electron affinity of the latter.

The observed parallelism in the influence of negative groups on the rate of sodium reaction as compared with the rate of substitution by a negative ion[4,5] can be explained by the presence of additional resonance in the transition state, similar to that which we derived for the sodium vapour reaction. In a substitution reaction $X^- + RX_1X_2 = XRX_2 + X_1^-$ the transition state will have the *threefold* resonance:

$$2. \quad (a)\ X^- \ldots RX_1X_2$$
$$(b)\ XRX_2 \ldots X_1^-$$
$$(c)\ XRX_1 \ldots X_2^-$$

where the component state *c* is due to the presence of the negative group X_2.

The latter type of resonance can be related to the mechanism postulated by A. Lapworth in his classical studies on the formation of the cyanhydrine anion from RCO and CN^-. In this sense we could write, for example, the accelerating effect which C = O has on the substitution of acetylhalide by halogen ions, as being due to the tendency $X^- \ldots \underset{X_2}{C} = O$. We could even extend this to represent the rapid reaction of the acetylhalides with sodium vapour in the sense

$$Na \ldots \underset{X}{C} = O.$$

M. G. Evans.
University of Leeds.
M. Polanyi.
University of Manchester.

[1] Butler and Polanyi, Nature, 146, 129 (1940); Baughan and Polanyi, Nature, 146, 685 (1940); Baughan, Evans and Polanyi, *Trans. Far. Soc.*, 37 (1941).
[2] Evans and Polanyi, *Trans. Far. Soc.*, 34, 11 (1938).
[3] Pauling, L., "The Nature of the Chemical Bond", p. 235 (1940).
[4] Polanyi, M., "Atomic Reactions", Williams and Norgate (1932).
[5] Meer and Polanyi, *Z. phys. Chem.*, B, 19, 164 (1932).

Structures of Thallium

Thallium at room temperature has a close-packed hexagonal structure, but this transforms at 230° C. into another structure which is given in the literature as face-centred cubic. This is based on the work of Sekito[1], who used specimens quenched from the melt and specimens containing other elements; his results cannot therefore be considered decisive, particularly since he does not give the purity of his materials.

We have taken photographs of Hilger thallium No. 7011 (99·995 per cent Tl) in the Debye-Scherrer camera described by Wilson[2]. At room temperature photographs of the hexagonal structure were obtained. Above 230° C. the photographs were not very satisfactory owing presumably to grain growth, as the metal is too soft to be finely filed. The lines present, however, did not fit in with the face-centred cubic structure, and measurement of a photograph taken at 262° C. with copper *K*-radiation showed that the pattern was mainly that of a body-centred cubic structure with $a = 3{\cdot}874 \pm 1$ A. Some of the hexagonal structure also was present. In the accompanying table a description of the photograph is given, and the observed and calculated positions of the lines are compared. Allowing for a systematic difference due to absorption, it will be seen that the evidence for the body-centred cubic structure is quite conclusive.

Indexes and Radiation	Intensity	$\sin^2\theta$ Obs.	$\sin^2\theta$ Calc.
110 β	medium	0·0645	0·0643
110 α	strong	0·0791	0·0789
1011 α	medium	0·0847	0·0848
1012 α	very weak	0·1427	0·1412
200 α	medium	0·1582	0·1578
211 β	medium	0·1945	0·1929
211 α	strong	0·2383	0·2366
220 α	weak	0·3174	0·3155
310 β	weak	0·3227	0·3216
310 α	medium	0·3963	0·3944
321 β	very weak	0·4533	0·4502
321 α	medium	0·5540	0·5521
330, 411 α_1	weak	0·7095	0·7087
330, 411 α_2	weak	0·7131	0·7122
422 α_1	very weak	0·9452	0·9449
422 α_2	very weak	0·9500	0·9497

The values of the lattice parameters of the hexagonal structure from our photographs are: $a = 3{\cdot}4496 \pm 2$ A., $c = 5{\cdot}5137 \pm 4$ A., $c/a = 1{\cdot}5984 \pm 1$, at 18° C.: these values are corrected for refractivity.

H. Lipson.
A. R. Stokes.
Cavendish Laboratory,
Cambridge.
Sept. 4.

[1] Sekito, S., *Z. Krist.*, 74, 189 (1930).
[2] Wilson, A. J. C., *Proc. Phys. Soc.*, 53, 235 (1941).

Propagation of Lightning Leader Strokes

The interesting suggestions recently put forward by Bruce[1] with regard to the mechanism of leader strokes are largely based on data relating to glow-to-arc transition. However, laboratory experiments indicate that such transition is a cathode-dependent phenomenon, a fact specifically stated in two of the articles[2] cited by Bruce. The current at which the glow develops into an arc is a most variable quantity[3] and is governed by the shape and material of the cathode.

Most authorities[4] seem agreed that, in the glow discharge, electrons are liberated from the cathode by positive ion bombardment or by photo-electric effect, and also in the gas by collision processes or by photo-ionization ; transition to an arc takes place when the conditions *at the cathode* are such as to initiate a much more copious source of electrons, namely thermionic emission or auto-electronic emission.

The propagation of a leader stroke depends on ionization processes in the gas. There seems no reason to suppose that a sudden transition will take place in the leader channel at a value of current which relates to the glow-to-arc transition between metal electrodes, where all evidence points to the importance of cathode mechanisms. Thus I consider that the experimental data on glow-to-arc transition are not directly applicable to the leader stroke, which is a gas-dependent phenomenon.

A feature of the propagation of leader strokes is their development in fields of relatively low gradient. The leader stroke must therefore carry forward as it advances a localized intense field about its tip in order that its progress may be maintained. To create such a field an excess charge of the appropriate sign is required in the channel. I would then suggest that one of the criteria relating to the propagation of a leader stroke is that the gradient along the ionized channel should be such that the electron drift speed is sufficient to ensure the continuous creation of this excess charge as the leader advances. The manner in which this excess charge is produced is probably as follows :

(1) *The negative leader stroke.* The average electron drift speed u cm. per sec. along the leader channel is in the same direction as the average speed v of advance of the channel tip. If n is the number of ion pairs created per cm. advance of the leader stroke, the number of electrons in the channel is $\frac{n\,v}{v-u}$ per cm., while the number of positive ions is n per cm. (the positive ions may be considered as virtually stationary in comparison with the more mobile electrons). There is then an excess of electrons in the channel, namely, $\frac{n\,u}{v-u}$ per cm., which maintains the negative character of the advancing leader.

(2) *The positive leader stroke.* The direction of electron drift in the leader channel is in the reverse direction to that of advance of the leader. The number of electrons in the channel is $\frac{n\,v}{v+u}$ per cm., while the number of positive ions is n per cm., so that there is a resultant excess $\frac{n\,u}{v+u}$ positive ions per cm. of channel.

Further details relating to the amount of excess charge required in a leader channel will be published in due course.

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[2] Todd, F. C., and Browne, T. E., *Phys. Rev.*, 36, 732 (1930) ; Fan, H. Y., *Phys. Rev.*, 55, 769 (1939).
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[4] Druyvesteyn, M. J., and Penning, F. M., *Rev. Mod. Phys.*, 12, 89-90, 140-41 (1940) ; Loeb, L. B., "Fundamental Processes of Electrical Discharge in Gases" (Wiley and Sons. New York, 1939), p. 605 *et seq.* ; Compton, K. T., *Trans. Amer. Inst. Elect. Eng.*, 46, 868 (1927) ; Seeliger, R., *Phys. Z.*, 27, 730 (1926) ; von Engel, A. and Steenbeck, M., "Elektrische Gasentladungen" (J. Springer, Berlin, 1934), Vol. 2, pp. 119, *et seq.*

Magnetization of Matter by Ultra-violet Radiation

I HAVE attempted to repeat the interesting experiments reported by Ehrenhaft and Banet[1] on the effect of ultra-violet radiation on "non-magnetic" and annealed pieces of iron. They stated that, with the simplest apparatus (for example, a cheap compass needle), they showed that poles were induced in various pieces of annealed iron, the poles being mainly north magnetic. The specimens were placed perpendicularly to the geomagnetic field and irradiated for periods varying from minutes to several hours. The poles, they state, were present in many specimens after several days.

My experiments were carried out under similar conditions, and, within the limits of sensitivity of the magnetometer used, they were entirely negative. This sensitivity was about 9,000 mm. at 1 metre per œrsted, and was such that a pole strength of 0·01 C.G.S. unit (or a magnetic moment of 0·05 C.G.S. unit) on the specimen tested could be detected clearly. A small compass needle was found to be less sensitive and reliable. In the various tests I used two types of ultra-violet source, direct exposures to within 10 cm. of the source and also at the focus of a quartz lens, exposure times ranging from minutes to several hours, various angles from 0° to 90° between radiation beam and specimen, and many specimens of the kind mentioned by Ehrenhaft and Banet. In no case was there a significant increase in magnetization. An occasional specimen, accidentally dropped, became magnetized by the earth's field.

It was shown that the weak poles (of order 0·01–0·1 C.G.S. unit) induced by placing a specimen in the earth's field and tapping it could be detected with certainty by the magnetometer, and often by the compass needle.

The first ultra-violet lamp used by me was an Osira, 125-watt, high-pressure type (General Electric Co.). Its glass globe had been removed, and the ultra-violet flux density in the region 3132 A. and less had been determined in previous work[2] (39 microwatts per cm.^{2} at 61 cm. horizontally from the source). The second source was a Mercra lamp, 125-watt, with ultra-violet filter bulb (British Thomson-Houston Co.).

I would like to know if anyone else has tried these experiments, and their results.

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July 16.

[1] Ehrenhaft, F., and Banet, L., NATURE, 147, 279 (1941).
[2] Edie, E. G., and Focken, C. M., *Trans. Roy. Soc., N.Z.*, 71, Part I (1941).

Distillation 'Constants'

WE have become interested in the relationships existing between some of the older 'distillation constants' and the more recent concept of relative volatility (α of Walker, Lewis *et al.*[1]). To find the rate of change with composition of total vapour pressure (P) of a binary mixture Rosanoff, Bacon and Schulze[2] put forward the general equation (deduced empirically)

$$\frac{dP}{dx} = \frac{1}{K}\log\left[p_1(1-x)/p_2x\right]. \quad . \quad . \quad . \quad (1)$$

p_1 and p_2 were the partial vapour pressures (at a particular temperature) of the components, the molecular fractions of which in the liquid were x and $(1-x)$. The constant, K, held for all cases and was evaluated as follows: When in a particular case where Raoult's law held, that is,

$$[p_1(1-x)]/p_2x = P_1/P_2 \quad . \quad . \quad . \quad . \quad . \quad . \quad (2)$$

and

$$P = p_1 + p_2 = P_1x + P_2(1-x) = (P_1 - P_2)x + P_2 \; ; \quad . \quad (3)$$

then $$\frac{dP}{dx} = P_1 - P_2 = (1/K) \log [p_1(1-x)/p_2x]$$

$$= (1/K) \log P_1/P_2 \; ; \quad . \quad . \quad . \quad . \quad (4)$$

whence $K = (\log P_1 - \log P_2)/(P_1 - P_2)$. . . (5)

P_1 and P_2 were the vapour pressures of the pure components (at the temperature in question). Rosanoff *et al.*[2] evaluated K for a number of pairs of liquids and extended their considerations to obtain liquid-vapour equilibria points from measurements of total vapour pressures, etc.

A relationship between K and α can be deduced as follows: Since by definition (Walker *et al.*[1])

$$\alpha = p_1/p_2 \left[\frac{1-x}{x}\right], \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (6)$$

equation (1) becomes

$$\frac{dP}{dx} = \frac{1}{K} \log \alpha \; (\text{or } \alpha = e^{K.dP/dx}) \; ; \quad . \quad . \quad . \quad (7)$$

whence

$$K = \log \alpha / \frac{dP}{dx} \; ; \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (8)$$

and for pairs of liquids which obey Raoult's law—equation (2)—and in general,

$$K = \log \alpha/(P_1 - P_2) \quad . \quad . \quad . \quad . \quad . \quad . \quad (9)$$

At a later date the relationship between α and other distillation constants[3] will be discussed.

Incidentally, the equation of Rosanoff *et al.* relating E_0 and x_0, the initial weight and initial molar fraction of a component in a binary mixture, with E and x, the quantities remaining in the mixture after a finite partial distillation, namely:

$$\ln \frac{E}{E_0} = \int_{x_0}^{x} \frac{e^{K.dP/dx}}{(e^{K.dP/dx} - 1)(1-x)x} . dx \quad . \quad . \quad (10)$$

can be written in the form

$$\ln \frac{E}{E_0} = \int_{x_0}^{x} \frac{\alpha}{(\alpha - 1)(1-x)x} . dx. \quad . \quad . \quad . \quad . \quad (11)$$

which on integration, provided α is constant, gives

$$\log \frac{E}{E_0} = \frac{\alpha}{\alpha - 1} \left[\log \frac{x_0}{x} + \log \frac{1-x}{1-x_0}\right]. \quad . \quad . \quad (12)$$

A similar equation may be written for the other component[4].

Reilly and Kelly[5] have shown that the distillation constant, k, for pairs of liquids used by Virtannen and Pulkki[6], is the same as α on the condition that Raoult's law holds. It is hoped to show in a later publication that this condition is not necessary. It would therefore appear that the technique of Virtannen and Pulkki[6] can be applied to determine α for pairs of liquids which form azeotropes. It should be noted that components which form an azeotrope deviate from Raoult's law. Even if Raoult's law has to be obeyed by the components for k and α to be the same, there would still be a possibility of the above method being applied to azeotropic components. Hildebrant[7] points out, in another connexion, that, in certain cases, it does not take much deviation from Raoult's law for an azeotrope to form. However, it would appear at the moment that the only criterion necessary for the similarity of k and α is that the relative volatility of the two components should be constant (or approximately so) through the temperature range of the small partial distillation necessary to determine k. In practice, a series of small partial distillations, or a single distillation into several small separate portions of distillate, is carried out to determine k for different compositions. Walker *et al.*[1] point out that, in general, relative volatility does not vary rapidly with temperature. Consequently, as a general rule, k should approximate to α in a given partial distillation. For an infinitesimally small partial distillation, k would become identical with α.

A pair of liquids mixed in the exact azeotropic composition has a value of α equal to unity. For other compositions α varies from values greater than unity to less than unity depending on which component is present in excess of the azeotropic composition in the mixture. The determination of k can be carried out quickly (even if using the more elaborate technique of Rosanoff, Bacon, and White[8] for distillation into separate portions of distillate) and the values of k for a range of compositions rapidly ascertained. If k approximates to α then a curve relating k with a range of compositions should have an inversion point, where an azeotrope is formed, at about the co-ordinates of k equalling unity and composition equalling that of the azeotrope.

In another connexion some of us have been examining the extraction of nicotine from aqueous solution[9]. On turning attention to the distillation of aqueous nicotine solutions some interesting results have been obtained. A preliminary determination of values of k for a series of dilute (one liquid phase) solutions of nicotine in water indicates that the curve relating k with composition shows an inversion point (as described earlier). Accordingly, the existence of an azeotrope of nicotine and water would be probable. This work is being completed and the liquid-vapour equilibrium curve for nicotine and water will be constructed to confirm the existence of an azeotrope.

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Sept. 15.

[1] "Principles of Chemical Engineering" (New York, 1927); 1937.
[2] *J. Amer. Chem. Soc.*, **36**, 1993 (1914).
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[4] cf. also "Perry's Chemical Engineers' Handbook" (New York, 1934), p. 1154; and Walker *et al.*, *op. cit.*, 2nd ed., 1937, p. 533.
[5] Article on "Distillation", Thorpe's "Dictionary of Applied Chemistry" (London, 1940), vol. 4.
[6] *J. Amer. Chem. Soc.*, **50**, 3138 (1928).
[7] "Solubility of Non-Electrolytes" (New York, 1936).
[8] *J. Amer. Chem. Soc.*, **36**, 1803 (1914).
[9] "The Distribution of Nicotine between Trichloroethylene and Water", *J. Chem. Soc.*, 275 (1941).

Oogenesis in Adult Mice and Starlings

It has long been the general assumption that, at least in the higher vertebrates, the stock of oogonia and oocytes laid down in the ovaries during embryonic life is never afterwards increased, and that in the adult the waves of maturing eggs are derived from this stock which lasts the animal throughout its active sexual life. In 1923 this theory was challenged by Allen[1], who had observed in the ovary of the adult mouse (*Mus musculus* L.) the formation of new oogonia from the mitotic divisions of the cells of the germinal epithelium. Depending on the plane of division, these mitoses resulted in the production either of new cells in the germinal epithelium or of new oogonia. Although the original theory is still widely held, much evidence confirming Allen's observations has now accumulated, and a review of present knowledge has been given by Swezy[2].

Investigations have been made which endorse Allen's statement that the mitotic activity of the germinal epithelium of the adult mouse ovary is a cyclic phenomenon. More mitoses are evident, and therefore more oogonia are produced, during the œstrous period than in any other period of the normal œstrous cycle. Allen did not, however, fully demonstrate how very intense and short-lived is this period of maximum production of new oogonia. In the strain of mice used in this laboratory, œstrus, as recognized by the typical vaginal smear, lasts for about forty-eight hours, and about thirty-six hours from the beginning of this period ovulation occurs. Œstrus is therefore divided into a long pre-ovulation period and a shorter post-ovulation period, the latter being equivalent to what Allen termed early metœstrum. Counts were made of the number of mitoses in the germinal epithelia of the ovaries of a series of normal mice in all phases of the œstrous cycle, and the results are given in Table 1.

TABLE 1.
Average numbers of mitoses in the germinal epithelia of ovaries of adult mice.

Period	Diœstrus 1st day	Diœstrus 2nd day	Diœstrus 3rd day	Pro-œstrus	Œstrus pre-ovulatn.	Œstrus post-ovulatn.	Met-œstrus
Mitoses	8	12	19	25	27	408	24
Number of mice	4	4	4	4	4	5	4

It is seen that a very sharp peak of mitotic activity is characteristic of the period immediately following ovulation, although there are also slight increases in the number of mitoses in both the pre-ovulation œstrous period and in metœstrus.

TABLE 2
Average numbers of mitoses in the germinal epithelia of ovaries of one-year-old starlings.

Month	April		May		June		July
Mitoses	0	5	30	8	0	0	0
Numbers of starlings	1	2	3	1	2	2	3

Oogenesis in many adult mammals is now an established fact, but little is apparently known about oogenesis in adult birds. During a study of the reproductive cycle of the starling (*Sturnus vulgaris* L.)[3] it was found that new oogonia are produced by the cells of the germinal epithelium, and further examination has indicated the presence of a cycle of mitotic activity similar to that of the mouse. The female starling when one year old usually lays one clutch of eggs, but when two or more years old it may breed twice in one season. Counts were made of the mitoses in the germinal epithelium of both first-year and older birds, and it was found that during the greater part of the year the germinal epithelium is quiescent. Mitoses, resulting in the production of new oogonia, are, however, common in the breeding season, and Tables 2 and 3 show the number of mitoses seen in the ovaries of starlings taken each fortnight from the beginning of April to the beginning of July.

TABLE 3.
Average numbers of mitoses in the germinal epithelia of ovaries of starlings of two or more years of age.

Month	April		May		June		July
Mitoses	0	4	34	11	22	2	0
Numbers of starlings	3	3	4	2	4	3	3

Ovulation takes place about the last week in April, and the greatest number of mitoses was observed immediately afterwards. In older birds, some of which ovulate a second time in early June, the counts of mitoses shown in Table 3 were made.

In addition to the wave of mitoses in early May, there is a second shorter and less intense wave coinciding with the end of the second ovulation in early June. By the end of June all activity of the germinal epithelium has ceased, and there are large numbers of small oogonia just below the tunica albuginea. These form a stock from which many of the next year's eggs are derived.

From these results it is evident that, both in the mouse and the starling, the mitoses of the germinal epithelium, resulting in the production of new oogonia, are at a maximum during very limited periods of the reproductive cycles, and in this respect the short cycle of the polyœstrous mammal is comparable with the yearly cycle of the bird. In both cases there is a sharp maximum of activity of the germinal epithelium in a short post-ovulation period. It appears probable that some factor which stimulates mitosis, and which is of an internal secretory nature, comes into full operation during this post-ovulation period. Further research on these lines is proceeding.

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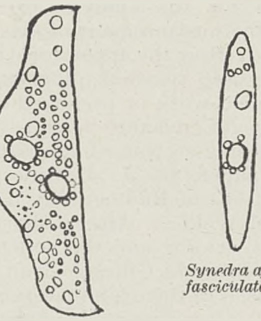
Sept. 1.

[1] Allen, E., *Amer. J. Anat.*, 31, 439 (1923).
[2] Swezy, Olive, *Quart. Rev. Biol.*, 8, 423 (1933).
[3] Bullough, W. S., "The Reproductive Cycles of the British and Continental Races of the Starling (*Sturnus vulgaris* L.)", unpublished.

Function of Pyrenoids in Algæ

THOUGH attempts have been made from time to time to explain the function of pyrenoids in Algæ, exact knowledge on the point is lacking. Usually starch is deposited around the pyrenoids in a good many Chlorophyceæ, and G. M. Smith[1] holds that pyrenoids synthesize starch. In starch-free diatoms G. Karsten[2] remarks that one has scarcely seen the actual formation of oils in connexion with pyrenoids. But by growing *Rhopalodia gibba* and *Synedra affinis* var. *fasciculata* in 2 per cent glucose medium, fatty acid and glycerine medium, etc., I could get distinct grouping of oil-drops around the pyrenoids (Fig. 1), the first-formed oil-drops in these diatoms being invariably deposited round the pyrenoids. Similarly, by growing green filaments of Spirogyra in fatty acids and glycerine medium, oil is synthesized in the course of three days in the form of drops (Fig. 2) around the pyrenoids within the starch-sheath. Chemical analysis confirms the utilization of acids in the process as the amounts of acids decreased during the process. Filaments of Spirogyra undergoing decomposition, either in Nature or in artificial culture, show the first formation of oil-drops around the pyrenoids within the starch-sheath as well as surrounding the sheath; here the starch-sheath becomes narrower and thinner—evidently oil is secondarily formed from the primarily formed starch-grains in the sheath.



Rhopalodia gibba. × 360. *Synedra affinis* var. *fasciculata.* × 720.

Fig. 1.

Thus, from these experiments it is held probable that pyrenoids serve as receptacles of appropriate enzymes for the syntheses of various food substances in such plants.

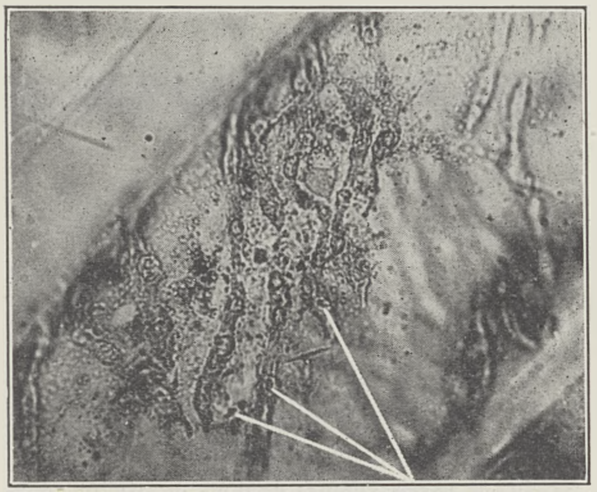


Fig. 2.

Spirogyra sp. Photomicrograph under oil immersion lens and eye-piece No. 5; oil-drops around the pyrenoids within the starch-sheath are marked by white lines.

The central portion of the pyrenoids gives the protein test with Millon's reagent, where a very faint pinkish stain is visible under the oil-immersion lens. In plants (both lower and higher) lacking in pyrenoids pinkish vacuoles are always found inside the plastids, and food substances are usually deposited in connexion with them. These pinkish vacuoles are not found in old, disorganized or plasmolysed cells.

It is hoped to publish the details of the work soon.

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June 10.

[1] "Fresh Water Algæ of the United States" (1933).
[2] Engler's "Nat. Pflanzenfam.", 2 (1928).

Biography of W. H. Wollaston

In 1931 I appealed in Nature[1] for information for a biography of William Hyde Wollaston. Since then, probably all printed information of any importance has been supplemented by a large amount of unpublished material. In the collection of the latter, much of which is of great interest, I have received very generous help from many sources.

Various circumstances have delayed the work, but in a way I do not regret the delay, because from time to time fresh material has come to light. Only a few weeks ago a large collection of letters from Wollaston to E. D. Clarke (1769–1822), professor of mineralogy at Cambridge from 1808, was reported in a bookseller's catalogue, and is now in my possession. It is possible that other Wollaston material which readers of Nature may know of is unknown to me. The dossier collected by Henry Warburton after Wollaston's death for the purpose of a biography was "lost", although I believe I have found a small fraction of it.

I am writing to record thus that the work is still in progress, and to issue one more appeal for information. Documents would be gratefully received by me, and would be returned by registered post as soon as copied; or, if correspondents would prefer that their documents were inspected under the ægis of an important library, Dr. T. Richards, librarian of the University College of North Wales, Bangor, where the section to which I belong of the Chemistry Department, University College, London, is enjoying hospitality, has kindly consented to take temporary charge of such papers.

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[1] Nature, 127, 340 (1931). The date of Wollaston's birth was there stated as 1765 instead of 1766.

Men of Science as Administrators

In a letter to Nature (May 31), R. A. Jones has well expressed the molluscan tendency of men of science to grow a shell and stay in it, and the difficulty of acquiring the arthropod ability to moult into an administrative stage. This difficulty exists in Canada also, but to a lesser degree, I think, than in England. The reaction to strong criticism may often be an invitation to "come and do it yourself, you who know so much".

It seems to be agreed that the peaceful penetration of government departments by men of scientific training and experience is desirable. I submit that for men of science engaged in 'near-economic' work such penetration is not difficult, given the will and political conscience to do so. Men of administrative experience are vulnerable on the side of economic development. As to the lack of administrative experience among men of science, which, as Mr. Jones points out, is considered a serious obstacle, it seems to me that if a classical education is looked upon as a sound foundation for the conduct of the affairs of the native populations of Africa, then a knowledge of the quantum theory should be as good equipment for the administration of civilized communities.

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CONFERENCE ON INDUSTRIAL RADIOLOGY

ON September 24 the Industrial Radiology Group of the Institute of Physics held the first meeting since its inauguration, this taking the form of an afternoon conference at the Royal Institution, presided over by Prof. J. A. Crowther. The Conference was opened by Sir William Bragg who first spoke of the early days of X-rays, almost fifty years ago, before commenting on the many industrial uses to which the radiations are now put. He welcomed the formation of a group of workers interested in radiology and hoped it will be a success in sharing experience and knowledge and also in stimulating further interest in the subject.

Three papers were read before the conference, forming the basis for the following discussion. The first of these, given by Dr. W. Betteridge, and entitled "The Application of X-Rays to Industrial Problems", was a general review of the subject. The physical properties of X-rays important in radiology were briefly described, and led to a consideration of the factors involved in the production of a radiograph. The points to be considered in the choice of the different variables such as tube voltage, tube to film distance, etc., were considered, and the importance of blocking off, the use of filters, intensifying screens and diaphragms were briefly described.

Various fields in which radiology has proved of service were then enumerated—the examination of castings and welded joints was mentioned but left for the following speakers to treat in more detail, and the miscellaneous uses of the rays were then described under grouped headings. The examination of assembled structures was considered to be the most important use after the two already mentioned, these being examined for the presence and correct alignment of component parts. Radio valves, small ammunition, shell fuses, electric heater elements, sparking plugs, etc., were mentioned as examples and slides shown illustrating the types of defect looked for. Such examinations are frequently carried out by fluoroscopic means. The routine examination of food products, fire bricks, arc carbons, etc., was also mentioned, and stereoradiography for the location of defects and the measurement of wall thickness was described. The observation of objects in a furnace was illustrated among uses in a research laboratory, and microradiography was dealt with. This latter consists of the radiography of a very thin metal sample on fine-grain film with soft radiation, subsequent optical magnification of the radiograph giving the equivalent of a photomicrograph, and showing the presence of different phases by the different degrees of absorption ; it was described as of particular value in the study of coring and segregation in a solid solution. The use of γ-rays in the examination of thick sections of heavy metals was mentioned.

A final section of Dr. Betteridge's paper dealt very briefly with the application of X-ray diffraction methods to industrial problems, reference being made to the recent symposium published in the *Journal of Scientific Instruments*. The Debye-Scherrer powder photograph was used to illustrate the different types of problem which could be dealt with, determination of the crystal structure, or its comparison with standards, being described for the identification of unknown materials in very small quantities, and the use of accurate parameter measurements for the analysis of alloys in solid solution and the measurement of elastic stresses was also mentioned. How the appearance of the diffracted lines could be used to yield information as to grain size, state of cold work or preferred orientation, and for the study of relaxation and recrystallization formed the closing section of the paper.

The next paper, by J. J. Gillespie, dealt with "The Applications of Radiography in the Inspection and Control of Welds". After a short description of the practice of welding and the bodies to which it is frequently applied, Mr. Gillespie dealt more fully with the methods used in the examination of welded joints in boilers and other pressure vessels. The need for careful preparation of the weld before examination was emphasized, in order that surface defects should not mask the internal faults for which search was being made ; and it was pointed out that the marking out of the body before radiography should be systematically and permanently done, so that at any future date the radiograph of a particular section could be located. Dark-room technique must be maintained at a high standard since an otherwise perfect radiograph can easily be spoiled by faulty processing. The common types of defect were then enumerated, the chief classes being porosity, slag inclusions, lack of penetration and cracks, and slides were shown to illustrate the different degrees and forms in which these faults could occur. It was stated that a certain amount of uniformly distributed porosity or slag inclusions can be tolerated in a weld, particularly if the metal is of fairly thick section, but lack of penetration and cracks are more serious defects likely to result in stress concentration, and a high standard of acceptance has to be maintained. Mr. Gillespie stated that a generally agreed standard of acceptance is becoming a necessity.

The third paper, on the "Application of X-Rays to the Examination of Magnesium Alloy Castings", was contributed by P. M. Bailey. It was first stated that fluorescent screen inspection of magnesium castings is unsatisfactory, as it is, in general, quite impossible to detect microshrinkage, the characteristic fault of these alloys, and the minimum size of fault detectable is about seven times as great as that shown on a radiograph. The type of X-ray film found most suitable for this work has a fine grain, and the highest contrast is not found desirable ; for this reason filters with an absorption up to 50 per cent of that in the casting itself are frequently used, although in general, filters are unnecessary for magnesium. Emphasis was laid on the use of a suitable viewing lantern, and modifications to commercial lanterns found necessary, such as the addition of blinds for reducing the area illuminated and the introduction of high-power lamps, were described.

Typical defects of magnesium castings were described, microshrinkage, which can reduce the tensile strength of the material from about ten to five tons per square inch, being paramount. The incidence of blow-holes and dross inclusions, both often due to faulty foundry technique, was mentioned, and it was pointed out that cracks, which, in the case of die castings, are usually due to poor dies, can easily be missed if the direction of the X-ray beam lies far from the plane of the crack. The necessity of close collaboration between radiologist and foundry manager was emphasized, and the procedure followed by Mr. Bailey himself was described. The breaking-up of castings in order to confirm and supplement radiographic inspection is essential, especially for the detection of microshrinkage ; this is helped by heat-treating the castings before breaking, the oxidation resulting making the microshrinkage more readily visible.

A lengthy discussion followed these papers and was contributed to by many speakers. Practical details, both difficulties which have been encountered and hints to overcome them, were mentioned, among the latter being the use of rubber cassettes which can be evacuated to hold intensifying screens in close contact with the film, the advantage of these being their flexibility, enabling them to be adjusted to close contact with irregularly shaped bodies ; and the use of mercury for blocking off holes in an otherwise uniform plate. The most important point raised during the discussion, however, was the need for standardization of the acceptable limit for given types of fault. It was generally agreed that standards for welds would not be too difficult to formulate, particularly since welds are usually in material of uniform section and regular shape, but it would be much less easy to arrive at similar standards for castings. The responsibility for the determination of standards was discussed and there was agreement that the final decision should rest with the designer of a component, the function of the radiologist being to interpret the radiographs to the designer.

It was decided that the Radiology Group of the Institute of Physics is not in a position to undertake the preparation of radiographic standards, but Dr. L. Mullins, the secretary of the Group, pointed out that standardization is very necessary in other fields, and hopes, for example, that the Group will be able to put forward suggestions which will result in a reduction of the many different types and sizes of camera used in X-ray diffraction work.

TECHNICAL ABILITY AND THE WAR EFFORT

A PRIME necessity in a war-time economy is for the maximum and most efficient use of all the country's resources. Particularly necessary in this War is the full use of technical man-power. After two years of war, when it is implied by Government spokesmen that we still lack sufficient material to contemplate an offensive against the enemy, it is disquieting to learn that there still exists a widespread misuse of technical man-power.

At a national conference for members in engineering and aircraft industries, held at Birmingham on September 7 under the auspices of the Association of Scientific Workers, delegates stated that many industrial scientists and technicians are still working on peace-time problems. Others with insufficient work to do are being kept together as teams and find the Essential Work Order used to prevent release from their present firms and the transfer of their ability elsewhere. Delegates made it clear that this situation has arisen from the concern of some industrial firms with the problems of post-war competition. Speakers criticized the absence of any proper pooling of information. They spoke of production being held up while technicians completed designs or solved problems already dealt with by a parallel organization, and of the withholding of full technical information from designers of apparatus.

There was criticism of the scientific ability of some persons at present in charge of technical staff. A delegate from the aircraft industry spoke of technical leadership being in the hands of former racing drivers.

Many speakers felt that the combination of inefficient management, the concern of firms for private interests, the scheduling of overtime as a pretence of activity when there is insufficient work to do and similar experiences have given rise to a general apathy regarding production and that it is necessary for this to be broken down by close co-operation between management and employees.

The remainder of the conference dealt with working conditions in these industries. Cases were put forward of qualified men receiving less remuneration than workmen under their supervision. Strong exception was taken to the system whereby university graduates rated as student apprentices are put on to ordinary production work at nominal salaries. Speakers clearly felt that little improvement in the status of scientific workers would be effected unless the Association of Scientific Workers could establish a minimum salary scale for all grades of scientific and technical staff.

The Conference therefore passed the following resolutions :

(1) All technical staffs not fully engaged on the war effort or engaged on development in preparation for post-war competition should be transferred to other departments.

(2) Real pooling of technical information and facilities should take place between firms producing similar articles, and between Government departments and firms producing for them.

(3) All scientific and technical work should be under the direction only of persons with adequate technical experience and qualifications.

(4) There should be genuine co-operation between managers and workpeople to secure greater enthusiasm for the war effort.

(5) An attitude of vigilance should be adopted regarding the working of the Essential Work Order, so that it shall not be allowed

(*a*) to hinder the war effort by permitting managements to retain staff when their transfer would be in the national interest ;

(*b*) to serve as an instrument of victimization of active trade unionists.

To carry this programme into effect the Conference proposed several points of action for the consideration of members of the Association, full details of which can be obtained from the Association of Scientific Workers, 30 Bedford Row, London, W.C.1.

THE NATIONAL RESEARCH COUNCIL OF CANADA

THE review of activities of the National Research Council of Canada for the year ending March 1940, which has now appeared, includes the report of the president, together with reports of the divisions and sections and reports of co-operative investigations, including the associate, joint and special committees.*

The president's report, referring to the re-alignment of work through the effect of the War, points out that many of the studies that were being carried out in peace-time proved of equal or greater importance in war-time, and the change over to a war-time programme involved very little departure from existing procedure. The Aeronautical Committee since the outbreak of war has been occupied almost exclusively on urgent military aviation problems, while the Radio Committee has undertaken a greatly enlarged and intensive programme directed exclusively by military considerations. With the outbreak of war, the Metrological Laboratory was considerably expanded to undertake the standardization of munition gauges. Scientific work of the Department of National Defence for the Services has included problems relating to the mechanical equipment, and other problems, of naval craft, such as the design and performance of hulls and the investigation of means of offence and defence in sea warfare. Research work for the Militia Service has covered war supplies, munitions manufacture, the examination of explosives and the provision of supplies for the troops, while for the Air Force the facilities of the Aeronautical Laboratories are used to determine the practicability of new designs of aircraft and engines, improvement in technique in construction and flight, engine performance and the effect of modifications in fuels and lubricants, etc. Other laboratories are being constructed outside Ottawa, and larger wind tunnels, both horizontal and vertical, are to be built, while a new model-testing basin will provide more adequate facilities for the study of ship and float design.

The National Research Council also maintained direct contact with similar scientific bodies in Great Britain, and since the beginning of the War the practice of exchanging scientific officers between Great Britain and Canada has been extended. The Section on Codes and Specifications is responsible for the preparation of commodity standards for Government Departments and for the development of a National Building Code as well as for general specification studies. The Research Plans and Publications Section, in addition to the maintenance of the Library, is responsible for the publication of the *Canadian Journal of Research*, the preparation of bibliographies on scientific subjects, and translations, and also conducts a research advisory service. With the recall of the president, Major-General A. G. L. McNaughton, to active military service, Dean C. J. Mackenzie took over the duties of acting-president in October 1939.

Dealing with the work of the main research divisions, the Division of Biology and Agriculture continued its work on plant growth factors, including the hormone treatment of seeds. These tests, carried out in co-operation with a number of organizations across Canada, indicated no appreciable benefit from such treatment of seeds when the hormone chemicals were incorporated in organic mercurial disinfectants or talc. Indolylacetic acid, however, proved effective in reducing injury by formaldehyde to germination in soil, and the dust method of applying synthetic hormone chemicals to plant cuttings had a further beneficial effect when the substances were used in combination with nutrient salts, sugar and organic mercurial disinfectants. Other work has been concerned with the propagation of forest trees from cuttings. Satisfactory results have been obtained with plant hormones applied as dust or in a mixture of equal volumes of sand and peat humus. Further work has been carried out on the standardization of the experimental baking test as well as studies on malt quality and the modification of malt. Among the work carried out on food storage and transport, the investigation of the canning of poultry and the development of rancidity in frozen pork during storage, as well as the curing of bacon by smoking in view of the dearth of refrigerated shipping space available, may be mentioned. Other work has been concerned with the control of storage conditions and also with the storage of blood for transfusion purposes. Statistical studies have been made of the effect of dust seed treatment with indolylacetic acid on the growth and yield of barley under closely controlled conditions.

In the Division of Chemistry, a major project was concerned with the preparation of ethylene oxide by direct oxidation of ethylene by air over catalysts, and some catalysts have been prepared which show sufficiently high activity and specificity to indicate that the process might be more practical than the chlorohydrin process for the manufacture of ethylene glycol. A new laboratory has been equipped for the study of synthetic resins and plastics, while the electrochemical laboratory has continued work on the corrosion of metals by used lubricating oils, the corrosion of metals and coatings by 'leaded' petrol under storage conditions, and a preliminary investigation of the corrosion of metals by hot and cold domestic tap waters and by softened laundry water. Investigations in the field of detergency as applied to laundering and dry-cleaning have been continued, as well as research on the possible harmful effects of certain textile finishing agents and methods of determining sizing and finishing compounds on cotton fabrics. In the Paint Laboratory, increasing attention has been given to protective coatings for use on aircraft, military vehicles and other equipment for war purposes.

The Division of Physics and Mechanical Engineering has been concerned with investigations on fatigue in aircraft propellers, the temperature control of refrigerator cars, development work on photographic apparatus for the Royal Canadian Air Force, and on the application of spectrochemical methods of analysis to agricultural problems.

Of the associated and joint committees, the Associate Committee on Aeronautical Research has been responsible for further work on the cathode ray compass tests, on the oil dilution system for cold-weather starting of aeroplane engines, the development of the apparatus to study vibrations in aircraft structures, fatigue of metal propellers and aircraft ski research.

Under the Advisory Committee on Field Crop Diseases, research in Alberta has indicated that seed

* National Research Council of Canada. Review of activities for the year ended March 1940. N.R.C. No. 976. Pp. 155. 75 cents.

treatment with formaldehyde is ineffective for preventing smut contamination. Copper carbonate and chloride were more effective, but the organic mercurial dusts were the best protectors. Research in Manitoba on liquid and dust fungicides for smut control showed that dust failed to control smut in oats and barley although the failure may have been due to the method of treatment given. Satisfactory control in wheat was obtained with solutions of organic mercurial compounds.

In work under the Associate Committee on Grain Research at the University of Alberta preliminary comparisons of the relatively injurious effects of the three organic mercury dusts, New Improved Ceresan, Laytosan and Lunasan, on wheat indicated that the first was more likely to cause injury in overdoses than the others. Further evidence was obtained indicating that treatment of seed wheat with formaldehyde renders it more susceptible to mould damage than untreated wheat, although the damage was apparently reduced by addition of certain fungicidal dyes and organic mercurial compounds to formaldehyde solution.

Progress has been made with breeding projects aimed at the development of drought-resistant varieties of wheat. Work on the development of rust-resistant smooth awned barley of good malting property has continued.

Under the Associate Committee on Medical Research a study is being made of the relation of certain food factors to the development of cancer, and attempts to prepare a synthetic chemotherapeutic agent for the treatment of tuberculosis and studies of the relation of certain dietary deficiencies and physical factors to the development of arthritis are in progress.

Two meetings have been held of the Canadian Committee on Oceanography, established in March, 1938, while under the Associate Committee on Parasitology studies of the enzyme inhibitors of Ascaris and of the anthelmintic action of phenothiazine have been carried out. In addition to the studies of the anthelmintic action of phenothiazine in sheep, a method of administration has been worked out by critical testing and a test is being conducted on its effect on a flock of cull lambs.

THE HELIUM METHOD FOR DETERMINING THE AGE OF ROCKS

By N. B. Keevil,
Department of Physics, University of Toronto

THE potentialities of radioactive methods of determining the ages of rocks, minerals and meteorites are so great that much time, money and effort have been expended in age research during the past decade. The supplement to the chemical method of the more elegant physical method of lead age determination from isotopic abundances has done much to establish confidence in the lead time-scale; but more hope has been held for the helium method because of its promised application to a great variety of geological materials rather than to a limited group of rare minerals.

It is now evident that the 'apparent age' or helium index calculated by the helium method is usually considerably lower than the age expected from geological and lead age data. Only in rare cases does the helium index seem to be concordant with the lead time-scale. This would not be so serious geologically if helium indexes were reasonably consistent, for it is not so much the absolute age as the sequence and relative time intervals which are of importance in geological problems. However, a survey of one hundred and fifty determinations on rocks has shown that there is only a one-to-one chance of finding the age of a basic rock within one geological period, that there is a still smaller chance of determining the age of a granitic rock, and that the results obtained for porphyries and lavas are meaningless from the point of view of age.

The discovery that differing values of the helium index are obtained for the different minerals constituent in rocks[1] led to the theory that the low results were due to selective loss of helium in minerals. Results recently obtained for one hundred and fifty minerals have shown a variation in the ratio of experimental age (helium index, I) to the expected age, A, from mineral to mineral and from rock to rock. No one mineral has been found to give uniform results. Since more than ninety per cent of the four hundred age determinations made to date show lower values than expected, the explanation that the variations are due largely to non-uniform loss of helium seems a logical one, and hence I/A may be termed the helium retentivity.

The results summarized in Table 1 show that the retentivity varies by a factor of 2500, but if the high values are excluded, most of the average values, and the probable values of retentivity obtained from distribution curves, fall within the range 0·3–0·6.

TABLE 1. HELIUM RETENTIVITIES OF ROCKS AND MINERALS

Type of sample	No. of samples (Keevil)	Helium retentivity			No. of samples (others)
		Range (Keevil)	Average* (Keevil)	Average† (others)	
Granitic rocks	34	0·02–0·86	0·25	0·35	6
Basic rocks	18	0·10–1·93	0·44	0·45	69
Porphyries and lavas	22	0·01–1·08	0·12	0·36	9
Quartz	14	0·04–1·22	0·25		0
Magnetite	10	0·24–12·3	0·46	0·93	18
Oxides	6	0·11–0·59	0·32	0·25	17
Feldspar	25	0·02–0·46	0·20	0·25	2
Femics	37	0·05–3·84	0·57	0·45	4
Silicates	22	0·12–3·63	0·41	0·34	29
Oxy-salts and halides	12	0·03–24·6	0·45	0·38	10

* Excluding 14 values indicating excess helium.

† Excluding 18 high values from data by Strutt, Holmes, Dubey, Kano, Davis, Lange, Urry, Goodman, and Hurley.

No significant disagreement exists between my results and data obtained by other observers. Rocks containing a glassy matrix are not comparable with crystalline rocks, since helium diffuses through glasses much more readily, and the discrepancy in the case of magnetite is discussed below.

Attempts to apply corrections on the basis of average helium retentivities have made little improvement in the accuracy of dating, although such correction does tend to place the helium ages calculated for different types of specimens on a more common basis. At the present time it seems that such corrections do not provide 'ages' of sufficient accuracy for use in geological correlation. A consideration of the local effects of metamorphism, and a more general plot of retentivity against expected geological age, show the discrepancies to be due in part to the variation in retentivity of minerals with geological history. It is fairly definite that low values of I/A are caused by metamorphic changes, deuteric action, some mineralization processes, and by weathering. In a series of Algoman hornblendes from one area, a relationship between the degree of alteration and helium index was found. It is also apparent that loss of helium may be caused by crystal imperfections, localization of the radioactive elements, and by interruptions in structure.

Two possible alternatives remain: first, the use of perfect minerals, if such can be found, and secondly, the correction of helium indexes by means of characteristic equations or curves for each mineral, such as retentivity-alteration curves. I have had some success with the second method, but it is doubtful whether a generally useful method can be developed. It is also uncertain whether any crystal can be said to be perfect so far as retaining its radiogenic helium is concerned; and the chance of its containing excess helium renders the result subject to error in any case.

Although it has been suggested that magnetite generally retains most of, if not all, its helium, and so gives reliable helium ages[2], results obtained in this laboratory indicate magnetite to be no better than some other iron minerals. Although some samples have appeared to give ages consistent with the lead time-scale and geological data, others have shown pronounced loss of helium, and a few have shown evidence of large amounts of extraneous helium. Furthermore, age determinations on other minerals separated from magnetite-rich samples have shown discordant results in all cases, the helium indexes frequently being higher than those for magnetite. The few examples given in Table 2 show the unreliability of using helium indexes of magnetite as criteria of age.

TABLE 2. SOME RESULTS ON MAGNETITES

Locality	Helium index, I	Expected age, A	"Retentivity", I/A
Magnet Cove, Ark. ...	42	150	0·28
Bushveld Complex, Africa	39,200	575	6·53
Port Henry, N.Y. ...	230	600	0·37
Franklin, N.J.	181	600	0·29
Yellowknife, N.W.T. ...	2,640	575	4·6
Yellowknife, N.W.T. ...	16,500	575	28·7

At the present time, insufficient is known of the causes of the discrepancies to permit correction of helium indexes, and while some mineral specimens give a value of I/A of unity, one cannot be confident from preliminary examination of the mineral that the 'correct' age will be obtained. It must therefore be concluded that the helium method in its present stage of development is not generally reliable as a means of geological correlation.

[1] Keevil, N. B., *Amer. J. Sci.*, **36**, 406–16 (1938): see NATURE, **143**, 32 (1939).

[2] Hurley, P. M., and Goodman, C., *Bull. Geol. Soc. Amer.*, **52**, 545–60 (1941).

FORTHCOMING EVENTS

MONDAY, OCTOBER 13

THE FARMERS' CLUB (at the Royal Empire Society, Craven Street, London, W.C.2), at 3 p.m.—Mr. James Mackintosh: "Feeding Livestock under War Time Conditions".

TUESDAY, OCTOBER 14

ILLUMINATING ENGINEERING SOCIETY (at the E.L.M.A. Lighting Service Bureau, 2 Savoy Hill, London, W.C.2), at 2.45 p.m.—Mr. W. J. Jones: "Light and Lighting—A Forward Outlook" (Presidential Address).

WEDNESDAY, OCTOBER 15

INSTITUTE OF FUEL (in the Connaught Rooms, Great Queen Street, Kingsway, London, W.C.2), at 2.30 p.m.—Mr. W. M. Selvey: "The Hundred Thousand, an Engineer's Philosophy" (Presidential Address). Dr. Clarence A. Seyler: "Recent Progress in Coal Petrology" (Melchett Lecture).

THURSDAY, OCTOBER 16

CHEMICAL SOCIETY (at Burlington House, Piccadilly, London, W.1), at 2.30 p.m.—Prof. I. M. Heilbron, F.R.S.: "Some Aspects of Algal Chemistry" (Eighth Hugo Muller Lecture).

FRIDAY, OCTOBER 17

NORTH-EAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS (at the Literary and Philosophical Society, Newcastle-upon-Tyne), at 6 p.m.—Annual General Meeting. Mr. W. A. Woodeson: Presidential Address.

SATURDAY, OCTOBER 18

NUTRITION SOCIETY (at Cambridge).—Conference on "The Evaluation of Nutritional Status". (See page 433 of this issue.)

APPOINTMENTS VACANT

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

PRINCIPAL of Melton Mowbray and District County Technical College—W. A. Brockington, Esq., Grey Friars, Leicester (October 14).

PSYCHOLOGIST—The Hon. Secretary, Cheltenham and County Child Guidance Clinic, Education Department, Municipal Offices, Cheltenham (October 15).

LECTURER IN THE DEPARTMENT OF PHARMACY—The Principal, Central Technical College, Suffolk Street, Birmingham 1.

ASSISTANT CONTROLLER OF TELECOMMUNICATIONS (ENGINEERING) for the Malayan Postal Service—The Crown Agents for the Colonies, 4 Millbank, London, S.W.1 (quoting M/9795).

LECTURER IN PRINCIPLES OF EDUCATION at Victoria College, Belfast—The National Froebel Foundation, 2 Manchester Square, London, W.1.

INDUSTRIAL CHEMISTS (preferably with works experience)—The Director, British Launderers' Research Association, The Laboratories, Hill View Gardens, Hendon, London, N.W.4.

ASSISTANT MISTRESS TO TEACH ELEMENTARY SCIENCE AND MATHEMATICS—The Headmistress, Day Technical School for Girls, Fort Pitt, Chatham.

FIRST CLASS HONOURS GRADUATE IN CHEMISTRY, WITH SUBSIDIARY PHYSICS—The Principal, University Correspondence College, Burlington House, Cambridge.

REPORTS AND OTHER PUBLICATIONS

(not included in the monthly Books Supplement)

Great Britain and Ireland

British Electrical and Allied Industries Research Association. Technical Report, Reference A/T83: Mechanical Behaviour of Bitumen. By W. Lethersich. Pp. 28. (London: British Electrical and Allied Industries Research Association.) 15s. [179

Other Countries

Proceedings of the United States National Museum. Vol. 90, No. 3108: Synopsis of the Tachinid Flies of the Genus *Tachinomyia*, with Descriptions of New Species. By Ray T. Webber. Pp. 287–304. Vol. 90, No. 3113: Pamlico Fossil Echinoids. By Willard Berry. Pp. 443–446+plates 63–65. (Washington, D.C.: Government Printing Office.) [179

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