# NATURE

No. 3770 SATURDAY, JAN. 31, 1942 Vol. 149


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## SCIENTIFIC ORGANIZATION OF SOCIAL ACTIVITIES

EXPERIENCE has indicated that some of the economic and social activities of a nation cannot safely be left to unguided individual initiative or interest. Education has long been reckoned as such a social activity, and most of the effort required to supply the essential needs comprised in the idea of the social minimum and embodied in what has been described as a new Bill of Rights for the citizen might be placed in the same category. Mr. Geoffrey Crowther, editor of the *Economist*, in an article in the American periodical *Fortune*, goes so far as to suggest that all activities connected with the supply of the nation's food, including production, as agriculture, and distribution and processing, should be planned and controlled by the nation in order that the new standards of nutrition, etc., may be secured. The magnitude of the problem suggests at once that it is by no means easy to draw a line beyond which the profit motive should not be permitted. It may be conceded, for example, that public health is definitely a matter for purposeful organized effort on behalf of the community and cannot be left to the operation of the profit motive. The implications of such a policy, however, are far-reaching and not all obvious. National health is the product of many factors, and some of them, not the least important, owe their primary stimulus, not necessarily, indeed, to the motive of profit or private gain, but certainly to that element of freedom which Mr. Crowther suggests should in theory be excluded from the social field.

The health of the community does not depend only on the general state of nutrition and the standard of living, including all those environmental factors involved in town and country planning, recreation, the location of industry, industrial welfare and the like, and on the social services, such as the health services themselves, whether preventive or remedial. These activities are clearly those which should be planned and run by the community with no consideration of profit and with the main object of effective service to the needs of the community. The public health depends further on the prosecution of scientific research, not merely into nutrition but also into the prevention and cure of disease, and it is at this point that, as is indicated by Sir Henry Dale's recent presidential address to the Royal Society and the recent announcement of the formation of the Therapeutic Research Corporation, there is a definite need for a mixture of the motives of freedom and service. Sir Henry Dale laid the major stress in his address on the importance of freedom and opportunity rather than organization as providing the conditions for the highest type of research. None the less he recognizes the necessity of organization if discovery is to be put to full use, and his example of the association of science with the State without weakening the freedom of the scientific worker so happily illustrated by the Medical Research Council indicates that balance between order and freedom for which Mr. Crowther pleads. Sir Henry holds that the existing

mechanisms for the support of science by the State, while susceptible of improvement, offer no threat to the freedom of science, nor does the wider use of the organized application of science and scientific method to problems of public welfare, or the more effective access of scientific knowledge to those responsible for government.

The train of thought started by Sir Henry Dale and Mr. Crowther thus raises the very pertinent question as to whether the organization of medical and pharmaceutical research is not a matter for the State acting on behalf of the community, and whether after the War the field of activity of the Medical Research Council should not be extended so as to remove or limit considerably the operation of the profit motive in this field. The subject is one which is ripe for fuller consideration, but it must be remembered that in this field the past experience of Government organization or direction does not warrant undue optimism as to the advantage of a radical change in policy. The related field of industrial health supplies a pertinent example.

A recent report of the Select Committee on National Expenditure commented on the neglect to make full use of the Industrial Health Research Board for the scientific study of questions affecting industrial health and the best use of labour. The Government comment on a specific recommendation regarding investigations on the best length of the working week, while accepting as a basis for action the results of the Board's investigations, and indicating that it is proposed to obtain information as to sections of industry or particular kinds of work into which the Board might make further investigations, does not touch the root of the Select Committee's criticism—the inadequate resources and staff of the Board. On this point the recent report of the British Medical Association's Committee on Industrial Health in Factories is far from reassuring; that it should be possible for such a report to characterize industrial health research as on the whole sporadic and unco-ordinated, reflects neither to the credit of Government or people.

The B.M.A. Committee is clearly right in holding that further effort is required to place industrial health research on an adequate and efficient basis. If we have due regard for the national health, we cannot tolerate a system which fails to provide essential staff for the Industrial Health Research Board, or requires its paid secretary to act also as chief medical officer to the Ministry of Supply, and relies too much on incidental research of the medical inspectorate of factories. In the absence of driving force from the Government, we cannot be content to leave research in this field to the medical departments of individual firms.

Whether a fresh organization should be established for this purpose, as recommended by the B.M.A. Committee, is quite another matter. The logical method would be to develop the national organization which already exists, and extend the work and resources of the Industrial Health Research Board, linking up its work with regional schemes or organizations covering particular industries as required. The contacts already established with individual firms should provide a starting-point or nucleus for further development, and the co-ordination and application of the knowledge already available is unquestionably a matter for the State.

There will be general agreement with the Committee as to the urgency of the matter, and if preoccupation with other matters is the only legitimate explanation, though no excuse, of the Government's neglect of the many problems in this field of the utmost importance to the nation's health that are awaiting solution, the stimulus must come in the first instance from the professional workers concerned. Not merely the medical practitioner but also others concerned with the problems of industrial health—the manager, the chemical engineer, the plant superintendent, the chemist, the labour manager, individually and through their professional associations, must address themselves to the task of educating both the Government and Parliament, as well as the nation at large, to the importance and urgency of these questions from the point of view of our maximum war effort as well as of the long-term health of the nation.

It is, indeed, on the faithfulness and earnestness with which scientific workers turn to this and like tasks of education that the effectiveness of reconstruction and the wider possibilities of a new order largely depend. Reconstruction and the new order to be established after the War will be conditioned—and limited—by the extent to which public opinion is prepared for the necessary changes and understands what is involved. The contribution of the scientific worker in this task of education is, indeed, far more vital than any contribution he may make in the actual administration of the schemes put into operation. Scientific workers as such have no special claims for administrative responsibilities, though their scientific qualifications should not, as so often happens, debar them from administrative office when they clearly possess, in addition, administrative ability. They do carry, however, a special responsibility for sharing in the task of educating the community to an intelligent understanding of the technical or scientific factors involved in public problems concerning health or in any other field.

The report of the Committee on Industrial Health in Factories, and also the formation of the Medical Planning Commission, show that the British Medical Association has under consideration a number of these urgent problems. Some other professional associations, such as the Royal Institute of British Architects, the Institute of Physics and the Institutions of Civil and of Mechanical Engineers, are also seeking to focus attention on the problems that lie immediately ahead. There are other categories of scientific workers who are far from showing signs of being asleep, even on matters not intimately connected with their own profession. The report on industrial health in factories, for example, contains the rather naïve suggestion that an industrial medical officer should be responsible directly to the managing director of his firm, and its proposals for a central advisory body to guide employers in making appointments may well meet with some criticism from within the profession.

It must, in fact, be admitted that scientific workers and other professional men are not necessarily able to take detached or objective views on matters of public policy that affect their own interests, nor even to apply scientific methods to problems outside the highly specialized field in which they are themselves engaged. No less than other sections of the community, they require educating, at least in outlook, and their professional associations, taken as a whole, are representative of conservative rather than of progressive elements. The responsibility for undertaking the task of education, whether within or without the ranks of the profession, lies the more heavily accordingly on the shoulders of those scientific and professional men who are awake to the needs and implications of the present situation. Whether or not the hopes that have been raised of a new and more bounteous world order are to be realized depends largely on the way in which this task of education is undertaken now. The Conference on Science and World Order held last September, the Conference on Science and the War Effort held in January, and the formation of the Medical Planning Commission of the British Medical Association are welcome signs that the task is already being undertaken.

## MODERN THEORIES OF ORGANIC CHEMISTRY

### Modern Theories of Organic Chemistry

By Dr. H. B. Watson. Second edition. Pp. viii+268. (Oxford: Clarendon Press; London: Oxford University Press, 1941.) 17*s*. 6*d*. net.

AT the present time organic chemistry is enjoying one of its recurrent periods of profuse activity: an activity manifest in two main directions. In the first, great and impressive advances are being made in the difficult task of unravelling the molecular structures of complex compounds of profound physiological and biological significance. A second characteristic feature of modern organic chemistry is its growing concern with the mechanism of reactions, and great efforts are being made to reach an understanding and eventual solution of this group of problems. In their elucidation the methods of physical chemistry and of physics find as much, if not more, application than do the classical methods of organic chemistry.

This peaceful penetration of the rich and fertile provinces of organic chemistry by the ideas and experimental methods of physics and physical chemistry has been steady and persistent during the last few decades, while in more recent years the pace has quickened. Both branches of chemistry have gained thereby and abundant material becomes available for an interesting story.

The four years which have elapsed since the publication of Dr. Watson's well-known volume have witnessed notable developments on the theoretical side of organic chemistry, and concise summaries of these have been woven into the fabric of the new edition now under review. The new edition, however, does more than incorporate new material: large sections have been carefully re-written and reference rendered easier by the more abundant use of sub-headings. Further, the order of treatment of various subjects has been revised, leading to improvements both in classification and logical sequence. Topics formerly omitted or merely mentioned in passing, probably being regarded as in too early a stage of development for a balanced review in the old edition, now take their appropriate place in this admirable survey, which covers a wide field in considerable detail. Despite its detail, it is a most readable book; its perusal is greatly helped by clearness of print and orderly arrangement of formulæ. The opening chapter now includes an extension of the earlier section on quantum mechanical resonance and its application to resonance between different bond structures, mesomerism and the stability of the hydrogen bond.

Chapter 4 includes notes on electron diffraction and molecular magnetism, particularly valuable in view of the important parts which these methods may be destined to play in the elucidation of molecular structure. The discussion of dipole moments, now arranged in a more coherent manner, is included in this chapter and its value enhanced by the inclusion of some of the more recent results brought to light by this line of inquiry. Similarly, the general discussion on the applications of the electronic theory of valency to organic chemistry, now forming Chapter 6, is arranged in better order and includes a description of the most recent experimental results and speculations; the account of mesomeric, electromeric and inductomeric effects, rather involved in the old edition, has been clarified and amplified.

A new chapter on esterification and hydrolysis gives an outline of the development of the current theories of these reactions; while the interesting subject of simple substitution reactions in aliphatic compounds, so exhaustively investigated during the past few years by Ingold, Hughes and their co-workers, deservedly receives full discussion in a further new chapter.

The chapter dealing with reactions in which the primary process involves addition to unsaturated compounds is enlarged and describes modern views on the mechanisms of the Knoevenagel, Perkin, Claisen and aldol reactions.

The increased space, now amounting to three chapters, devoted to stereochemistry is an indication of the greater interest being taken to-day by

the general organic chemist in this important subject. It includes a concise but adequate account of the Walden inversion—a notable omission from the first edition but a welcome addition to the second—a discovery for long regarded as a kind of chemical Cinderella but the further investigation of which has yielded so much valuable information bearing on the mechanism of replacement reactions. This is followed by a short description of the application of kinetic methods to stereochemical problems together with a judicious review of current theories on the mechanism of reactions which involve a change of molecular configuration.

The new edition contains some fifty pages more than the old; despite this increase in size and the present difficulties of publication, the price of this excellently produced book has been raised by only half-a-crown; for this achievement the publishers deserve our congratulations.

J. KENYON.

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## THE MAMMALS OF INDIA

### The Fauna of British India: including Ceylon and Burma

(Published under the patronage of the Secretary of State for India.) Edited by Lt.-Col. R. B. S. Sewell. Mammalia, Vol. 2: Carnivora (continued from Vol. 1), Suborders Æluroidea (part) and Arctoidea. By R. I. Pocock. Pp. xii+504+12 plates. (London: Taylor and Francis, Ltd., 1941.) 35*s*.

THE volumes on mammals by Blandford in the first edition of "The Fauna of British India", have long been out of date and the large amount of new material has called for a new edition. Mr. R. I. Pocock, whose knowledge of the subject from long experience, both at the British Museum and the Zoological Gardens, is second to none, has now produced the second volume of the second edition, the first, by the same author, having been reviewed in NATURE of February 3, 1940, p. 164.

As in Vol. 1, the author has shown great thoroughness and an infinite amount of careful research. He continues with the order Carnivora, commenced in Vol. 1, and deals with the families Herpestidæ, Hyænidæ, Canidæ, Ursidæ, Ailuropodidæ, Ailuridæ and Mustelidæ. One is struck by the minuteness of the details investigated by Pocock, who has not overlooked characters which former authors, with less opportunities, have missed; and not only has he described such characters, many of which have proved of value in classification, but he has also skilfully illustrated them by line drawings, those of the soft parts being mostly from fresh specimens that had died in the Zoological Gardens. His drawings of the whole animals are also very good and show the characteristic attitudes and markings of species of which no photographs are available; but it seems a pity to adopt this method of illustration where good photographs could have been obtained, such as in the case of the giant panda.

Of this strange and interesting animal the author has a good deal to tell us, though he admits that it has not yet been discovered within the precincts of British India. It was, however, referred to by Blandford in the original edition of the present work, and there seems a possibility of its turning up in the near future in Upper Burma. Moreover, we are told of a closely allied and recently extinct species of which a complete skull was found in Upper Burma.

The arrival in Great Britain of living specimens of the giant panda a few years ago caused no little sensation, as it was supposed to be one of the rarest mammals in the world. It is a carnivore that has adopted an entirely vegetarian diet, its principal food consisting of the shoots and stems of bamboo up to half an inch or so in diameter which its powerful jaws enable it to chew with ease. It was interesting to watch the method of feeding adopted by those at the Zoo, and to notice the way the shoots were firmly held in a front paw as easily as a monkey holds food in its hand. In order to enable this bear-like creature to use its front feet as hands these have been modified by the provision of "an accessory lobe which covers the tip of a slightly movable elongated bone developed from the carpus and lying alongside the metacarpus of the first digit, and completely enveloped in the skin of the paw so as to be entirely invisible without dissection".

In a book of this sort, containing as it does a mass of detail invaluable to systemists though less interesting to the general reader, it is good to find full accounts of the habits of the animals where these are known.

Mongooses are represented in India by a number of species the habits of which seem to be very much the same in all. They somewhat resemble stoats in being alert, usually fearless creatures with the habit of sitting erect on their hind quarters to increase their range of vision. They are superior to cats in the matter of vermin killing, as they can enter the burrows of their prey and dig it out, and they fearlessly attack snakes and other pests which cats will not deal with. If captured young they are easily tamed and prove most efficient agents in destroying rats, snakes, scorpions and other objectionable intruders. It was the small North Indian species that was, in 1872, introduced into Jamaica to combat the pest of rats which inflicted great damage on sugar cane plantations. The

experiment proved eminently successful in reducing the numbers of the rats and was adopted by planters in adjoining islands. But the author does not mention the regrettable effect this introduction had upon the interesting avifauna of the islands, many of the ground-frequenting birds being virtually exterminated, while, it is said, the rats soon commenced to develop tree-nesting habits and so saved themselves from utter extermination from the mongooses, which are not good tree-climbers.

As a snake-killer the mongoose is greatly valued in India since it fearlessly attacks poisonous as well as non-poisonous kinds. It is not, we are told, immune to the effects of snake poison as has been asserted, but it almost invariably succeeds in evading the deadly fangs chiefly by its extreme activity in dodging the reptile's strokes. It is aided, too, by the long hairs of its body, which, during an encounter, are all erected, making its apparent bulk more than doubled, and it presents to the snake's aim a large area through which the fangs pass harmlessly.

The origin of the domestic dog has always been somewhat of a mystery though its affinity to the wolf has never been doubted. The author considers it a certainty that the wolf is the principal if not the sole ancestor, though admitting that the view that the jackal may have contributed to the strain cannot be dismissed, considering that some of the dogs possessed by Neolithic man were comparatively small. As the author remarks, "there is no mistaking the stamp of the wolf on such breeds as the Alsatian and the Eskimo", but it is difficult to imagine this ancestry in the case of the Pekingese or Griffon.

This book will long remain the standard work on the very rich mammalian fauna of the countries with which it deals. D. SETH-SMITH.

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## THE PRINCIPLE OF RELAXATION

### Relaxation Methods in Engineering Science

A Treatise on Approximate Computation. By Prof. R. V. Southwell. (Oxford Engineering Science Series.) Pp. vii+252. (Oxford : Clarendon Press ; London : Oxford University Press, 1940.) 17*s.* 6*d.* net.

THOSE who heard Prof. Southwell's lecture to the London Mathematical Society in 1937 will well remember how he communicated to his audience some of the great enthusiasm with which he had reacted to the method of relaxation, first advanced by Prof. Hardy Cross in 1932, and introduced to Great Britain by Prof. J. F. Baker, J. Morris and D. Williams (Aeronautical Research Committee, R. & M., 1667, 1670 and 1672). The great attraction of the method is that the engineering problem of estimating the stresses in a redundant steel framework is solved by a process of successive approximation, each step in which represents a definite engineering operation on the framework.

Imagine each joint fixed in position, and orientation by suitable jacks. As the prescribed loads are applied to the structure, the jacks are called upon to supply greater and greater constraining forces. Now ease off the jack carrying the greatest load, until it provides no constraint. The loads on the jacks holding the adjacent joints will change and so will the stresses in the adjacent members. Choose the jack which now carries the greatest load and ease *that* one off. It is evident that by this process we are approaching the condition in which no jack provides any constraint. Now Hardy Cross showed that the redistribution of loads and stresses due to slacking off one jack is easily calculable for an unbraced framework precisely because only adjacent joints and members are affected ; and Morris and Southwell have extended his method to braced frameworks including members with end loads. We have therefore a method of successive approximation to the stresses in a given framework when no external forces constrain the joints. As Southwell said in his lecture, "You can describe this process in mathematical language, but when I talk about relaxation I can see the workmen at the jacks spitting on their hands".

The method of systematic relaxation, as developed and applied by Southwell, has become one of the most important methods of practical computation in modern engineering science. Its scope is by no means restricted to those problems of redundant structures in which it attained its first successes. In the hands of Southwell and of the school of research workers which he has established at Oxford, relaxation methods have been successfully applied to a bewildering variety of difficult and outstanding problems of plasticity, conformal transformation, vibrating systems, percolation and the like. Many of these applications are described in the present volume. Naturally, these advances have to be purchased at a price—that of careful and laborious computation according to the systematized process developed by Southwell—but, in the words of one of Southwell's students, "The method works if the computer is prepared to".

The present volume gives a masterly account of the applications of the relaxation method, and is invaluable for the engineer who is well acquainted with the mechanics of frameworks. But, if I may be allowed a personal criticism, I found it a difficult book to read. I think this difficulty arises

because the reader is faced simultaneously with an entirely new method, and with somewhat specialized problems of stressing, vibrations, etc. What is really required is an introductory chapter explaining the essence of the relaxation method, a chapter which should be entirely abstract and mathematical and unencumbered by the details of practical problems.

The possibility of writing such an introduction arises from the fact that, to the eye of the mathematician, most of the early problems tackled by relaxation methods reduce in the last analysis to the solution of a set of linear simultaneous equations, while the practical difficulty of computation is due to the fact that the number of independent unknown variables is large, for example, a dozen or more.

Various methods of successive approximation have been devised for the solution of this type of problem, such as the powerful iteration methods due to Morris. Many (if not most methods) including the relaxation methods, require the system of linear equations to be "prepared" for computation by being reduced to the "normal" form. In this form the equations represent the conditions that a quadratic form in the unknowns should be an absolute minimum. This simple remark leads to a geometrical interpretation of the relaxation method, which is most easily visualized in the simplest case when there are only two unknowns.

The quadratic form to be minimized then represents the contour of a valley, the unknown variables being interpreted as latitude and longitude, and the numerical value of the quadratic form as height above sea-level. To minimize the quadratic form is to reach the lowest point in the valley in a thick mist, with no map, but having a compass. Southwell's relaxation method directs the lost explorer to walk downhill due north (or south) until the track he is following becomes momentarily level. Then to walk downhill due east (or west) until his track again becomes momentarily level; and thus to zig-zag down the valley sides until he is sufficiently near the absolute bottom part of the valley.

The method is delightfully simple and it suggests an obvious alternative. Instead of taking the direction of each walk to be due north or east, the explorer can take each walk in the direction of the line of steepest descent at the starting-point of each walk, and can continue the walk until the track he is pursuing becomes momentarily level. This procedure smooths out the zig-zags of the relaxation method, and for some time I thought that the method of steepest descent was an improvement upon the original relaxation method. A direct comparison of the two methods on the same problem soon showed, however, that the original relaxation method is much easier to apply and slightly more rapid.

An introduction on some such lines as these would, I think, be a great help to the novice—and most of us are novices when confronted with the type of problem discussed in this book. But, apart from this suggestion, the present work is above criticism, and Prof. Southwell has made us all his debtors by making his pioneer researches on relaxation methods available in such a convenient and delightful form. G. TEMPLE.

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## TORSIONAL VIBRATION PROBLEMS

Practical Solution of Torsional Vibration Problems With Examples from Marine, Electrical, Aeronautical and Automobile Engineering Practice. By Dr. W. Ker Wilson. Second edition. Vol. 2. Pp. xxi+694. (London: Chapman and Hall, Ltd., 1941.) 42*s*. net.

THE objective treatment of the subject of torsional vibration which has been adopted by Dr. W. Ker Wilson leads inevitably to the call for more and yet more examples of the practical solution of problems such as arise in this increasingly important branch of the designer's work. The original single-volume treatise has now been enlarged to two very substantial volumes which greatly increase the scope of the work. This at the same time gives opportunity for the re-writing of sections such as that dealing with damping devices, which has been brought up to date and now includes a separate chapter on the rotating pendulum vibration absorber.

The second of the two volumes has recently been published, and the main feature of the presentation of the subject lies in the solution of problems met with in practice. It is, however, very far from being a fortuitous assortment of examples of this class of work, as there is a logical sequence of development of the subject. The volume opens with the determination of stresses due to torsional vibration at resonant speeds, and proceeds to the measurement of amplitudes, analysis of torsiograph records, damping and absorbing devices and dynamic characteristics of direct-coupled electrical generating sets.

There are some thirty worked examples which appear in their natural sequence in this order of treatment. The examples showing the harmonic analysis of vibration records, using 24 and 48 ordinates, provide a valuable guide to the solution of such problems when a mechanical analyser is not available. It may be confidently stated that Dr. Wilson's book will do much to simplify the application of vibration study to modern needs.

## University Physics

By Dr. F. C. Champion. Part 3: Light. Pp. vii+172. 5*s*. 6*d*. net. Part 4: Wave-Motion and Sound. Pp. vii+67. 5*s*. net. (London, Glasgow and Bombay: Blackie and Son, Ltd., 1941.)

THESE two books form part of a complete course in physics for university students. Both books are clearly and soundly written, and are excellently produced. There is a group of examples after each chapter, and at the end of each book there is a number of questions with answers and useful hints for solution.

"Light". In a book avowedly written for university students, and occupying only 172 pages, it is rather surprising to find space taken up with elementary work. Certain sections are marked with an asterisk indicating that Intermediate students may omit them, but not everybody will agree with Dr. Champion's selection of the parts to be omitted. The chapter on photometry is very good, though probably more information might have been given on photo-electric instruments, while the chapter on the emission and wave theories of light is excellent and makes one wish for more.

"Sound". In this book, which runs to only 57 pages of text, Dr. Champion starts with a treatment of wave motion and simple harmonic waves. This is an excellent beginning, but as one goes through the book one finds that in many cases just the basic information is given. This is probably the author's intention; nevertheless the students for whom the book has been written will require more.

Undoubtedly what Dr. Champion has given is excellent, but he has not given enough; a bibliography of reference books would probably have been helpful to students.

## Mathematics for Engineers

By Raymond W. Dull. Second edition. Pp. xviii+780. (New York and London: McGraw-Hill Book Co., Inc., 1941.) 35*s*.

THIS is the second edition of the author's treatise on mathematics designed for engineers. It was originally published in 1926 and the major change in this new issue lies in the addition of several new operations with the slide rule—which the writer calls the "engineer's assistant"—made possible by modern improvements in the design of that useful instrument. The course is intended to bridge the gap between the engineer's handbook and the purely mathematical text-book, the former being too concise and incomplete, while the latter is too specialized. Considerable space is assigned to the treatment of error—absolute and relative—and to practical use of the slide rule.

The artificial boundaries between the various branches of the subject are commendably swept aside and, between the simple arithmetic of the first chapter and the multiple integration of the last, there is, in the intervening fifty-five chapters, a comprehensive and practical review of algebra, pure and analytical geometry, mensuration, trigonometry, including complex numbers, and calculus. The text is well illustrated by worked examples and clearly drawn diagrams. A few minor misprints are noticeable in which the phrase, "knots per hour", may be be included. As a review and work of reference, the book should be quite useful to those for whom it was written. F. G. W. B.

## The Foundations of Geometry

By Prof. Gilbert de B. Robinson. (Mathematical Expositions, No. 1.) Pp. xi+167. (Toronto: University of Toronto Press, 1940.) 2 dollars.

THERE are several excellent treatises dealing exhaustively with modern ideas of geometry and analysis, but the bulk and difficulty of these works repel those who are not specialists. The University of Toronto is publishing a series of "Mathematical Expositions", which will present topics in a readable fashion, with particular attention to showing how modern theories of mathematics arise naturally from considerations well known to elementary students. The first volume, Prof. Robinson's "The Foundations of Geometry", carries out this programme so far as it concerns the more usual kinds of geometry, leaving non-Euclidean geometry to be dealt with in a later volume. Part I considers the axiomatic foundation of projective geometry and of Euclidean geometry, and shows the relation between these. Part II deals with the more difficult questions of number, order and continuity. Those with a good knowledge of school geometry should find the book very helpful as a bridge between the old domains and the new.

Future volumes in this series will include "The Infinite in Mathematics" and "The Theory of Interest".

## Opera hactenus inedita Rogeri Baconi

Fasc. 16: Communia Mathematica Fratris Rogeri. Partes prima et seconda. Nunc primum edidit Dr. Robert Steele. Pp. xii+162. (Oxford: Clarendon Press; London: Oxford University Press, 1940.) 15*s*. net.

ROGER BACON (1214–1294) produced in 1267 his four-volume Latin encyclopædic treatise ("Opus Majus") on the foundations of knowledge, with two supplements dealing with physical science and mathematics. The "Communia Mathematica" appears to be an amplified version of the second supplement, assembled from various manuscripts by someone unknown, probably about 1428. For the modern reader the interest of the work is mainly in showing what mathematical literature and teaching were available at the time, and what Bacon thought of the teaching of Boethius, who moulded scientific thought of the early Middle Ages until the complete acceptance of Aristotle's physics. The first part of the "Communia" deals with the relation of mathematics to other branches of learning. The second part considers certain parts of mathematics in detail, particularly the theory of proportion. The criticism of some of Euclid's assumptions and definitions shows that Bacon was far in advance of this time. As is well known, he was accused of magic and condemned to imprisonment for life.

## Differential Equations

By G. S. Diwan and Prof. D. S. Agashe. Pp. x+316. (Bombay: Prof. D. S. Agashe, St. Xavier's College, 1941.) n.p.

THIS book, intended for a first degree course in Indian universities, gives a rather detailed account of the usual devices for obtaining a compact solution of differential equations designed to yield to the appropriate device. For this purpose it may be found useful. L. M. M.-T.

# MECHANISM AND CHEMICAL KINETICS OF ORGANIC REACTIONS IN LIQUID SYSTEMS*

By DR. E. D. HUGHES
University College, London

THE theory of chemical kinetics owes much of its development to the ease with which organic reactions lend themselves to convenient measurement, but the debt has been amply repaid, for kinetic studies have contributed very materially to the elucidation of the mechanism of organic processes. The importance of the kinetic method in the study of mechanism was demonstrated many years ago, particularly by Lapworth, Orton and others in the early years of the present century. More recently, it has been given enhanced value by the important advances in the physical interpretation of kinetic data (especially in liquid systems), and it has played a notable part in the rapid development which the theory of organic reactions has undergone since the enunciation of the electronic theory of valency. Of the conclusions derived from investigations in this field in the last decade, one of the most important, and one which is widely illustrated in this discussion, is that a reaction may follow different mechanisms in not very drastically altered circumstances. This fact emphasizes still further the importance of kinetic control in the study of reactions. With the aid of kinetics, chemical behaviour can be related to mechanism and its determining factors, chemical structure and physical conditions, and the solution of outstanding problems can thus be greatly facilitated.

The reactions which come under review involve three main processes which are quite closely related, namely, substitution, elimination and addition. The substitution reactions may be divided into three principal types, as illustrated in the following table (the dots in the formulæ representing electrons)[1]:

TYPES OF SUBSTITUTION.

(*A*) **Heterolytic**

(1) Nucleophilic

$$Y: + R|..X \rightarrow Y{-}R + :X \quad .... \quad (S_N).$$

(example: $HO^- + R{-}Cl \rightarrow HO{-}R + Cl^-$)

(2) Electrophilic

$$Y + R..|X \rightarrow Y{-}R + X^+ \quad .... \quad (S_E).$$

(example: $D^+ + R{-}H \rightarrow D{-}R + H^+$)

(*B*) **Homolytic**

$$Y. + R.|.X \rightarrow Y{-}R + .X$$

(example: $D + H{-}H \rightarrow D{-}H + H$).

The mechanism of reactions related to the first of these types will now be discussed; reactions of the second and third type are considered in the sequel.

In a simple nucleophilic substitution[1], of the form $Y + R{-}X \rightarrow Y{-}R + X$, the nucleophilic reagent $Y$, whatever its original charge, must become one unit more positive, and the expelled group $X$ one unit more negative; $Y$ may therefore be either negative or neutral (for example, $I^-$, $OH^-$, $NR_3$, $SR_2$, etc.), and $X$ either formally neutral or positive (for example, Cl, $NR_3^+$, $SR_2^+$, etc.). The kinetics of these reactions call for the recognition of two distinct mechanisms. The first is a one-stage process, which is termed 'bimolecular' because two molecules are undergoing covalency change:

$$Y: \curvearrowright R \leftarrow X \longrightarrow Y{-}R + X \quad .... \quad (S_N2).$$

(In this formulation, and elsewhere in this article, arrows are used to show the direction of electron displacements; sign labels on $X$ and $Y$ have been omitted because of the various possibilities already mentioned.) The second mechanism is a two-stage process, wherein a rate-determining ionization is succeeded by a reaction between the formed carbonium ion and the substituting agent:

$$\left.\begin{aligned} R \leftarrow X &\longrightarrow R^+ + X \\ Y: \curvearrowright R^+ &\longrightarrow Y{-}R \end{aligned}\right\} \quad .... \quad (S_N1).$$

This mechanism is termed 'unimolecular', because only one molecule ($R{-}X$) is undergoing covalency change in the rate-determining stage. The unimolecular mechanism is favoured relatively to the bimolecular mechanism by the following principal factors: (1) low nucleophilic activity in the reagent $Y$, (2) large electron-release from the group $R$, (3) strong electron-affinity in the group $X$, (4) high ionizing capacity in the solvent. It may also be added that the unimolecular mechanism is less sensitive to steric inhibition by substituent groups than is the bimolecular mechanism. When the reaction centre is asymmetric, the bimolecular mechanism invariably leads to inversion of configuration, while the unimolecular mechanism may give rise, depending on structural influences, either to retention of configuration or to racemization with predominating inversion.

For certain simple substitutions of the type now considered, Polanyi and others have calculated the activation energies to be expected on the basis of the above mechanisms. The values thus deduced are in reasonably good agreement with the experimental results. In the case of the 'symmetrical' halogen-exchange reactions (bimolecular), for example, $Cl^- + CH_3.Cl \rightarrow Cl.CH_3 + Cl^-$, a very simple method of calculation has now been described[2]. In first approximation, the activation energy is taken as the energy necessary to extend the carbon – halogen bond until it has the length corresponding to a carbon atom and a halide ion in contact, and it is shown that the introduction of various refinements into this procedure does not materially affect the result.

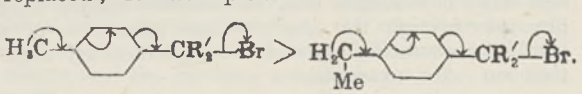
The same fundamental mechanisms operate in aromatic side-chain substitution[3], but interesting differences of behaviour are sometimes observed when the polar effects of certain substituents in the nucleus are compared with the effects of the same substituents when attached to a saturated system. With alkyl groups, for example, the predominating influence with respect to a reaction in a saturated system, such as the replacement of halogen in an organic

* This article is based on the Faraday Society's recent discussion on this subject (*Trans. Faraday Soc.*, **37**, 601, *et seq.*; 1941). References to the papers contributed to the discussion are given by noting the authors, employing the following key:

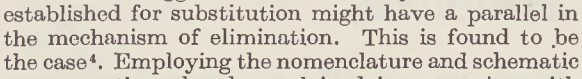
[1] E. D. Hughes.
[2] E. C. Baughan and M. Polanyi.
[3] J. W. Baker.
[4] E. D. Hughes and C. K. Ingold.
[5] J. N. E. Day and C. K. Ingold.
[6, 7] H. B. Watson.
[8] M. P. Balfe and J. Kenyon.
[9] G. M. Bennett.
[10] A. E. Bradfield and B. Jones.
[11] F. Fairbrother.
[12] G. Williams.
[13] W. A. Waters.
[14] J. Weiss.

A full discussion of the various topics, with literature citations, is contained in these papers.

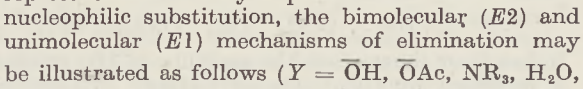
halide, $R-CR'_2-Br$, by the usual mechanisms ($S_N1$ and $S_N2$), is the general 'inductive' effect, which increases from left to right in the series, $R = CH_3$, $CH_3.CH_2$, $(CH_3)_2CH$, $(CH_3)_3C$; thus $CH_3 \rightarrow CH_2 \rightarrow CR'_2 \rightarrow Br > CH_3 \rightarrow CR'_2 \rightarrow Br$. When the unsaturated aromatic nucleus is interposed between the alkyl group and the reaction centre, however, another effect gains in importance and occasionally becomes the dominant influence; this is the 'electromeric' effect, which arises from suitably placed C—H bonds and decreases as the operative hydrogen atoms are replaced; for example:



Substitution and elimination occur together so often as to suggest that the duality of mechanism established for substitution might have a parallel in the mechanism of elimination. This is found to be the case[4]. Employing the nomenclature and schematic representation already explained in connexion with nucleophilic substitution, the bimolecular ($E2$) and unimolecular ($E1$) mechanisms of elimination may be illustrated as follows ($Y = \bar{O}H$, $\bar{O}Ac$, $NR_3$, $H_2O$, etc.; $X =$ .Hal, $.SO_2R$, $.\overset{+}{S}R_2$, $.\overset{+}{N}R_3$, etc.):

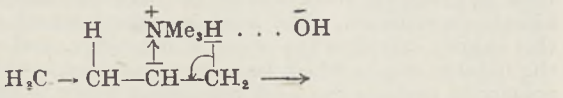


$$YH + CR_2{=}CR_2 + X \quad \ldots (E2)$$



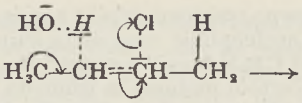
$$\left.\begin{array}{l} H{-}CR_2{-}CR_2{-}X \xrightarrow{(slow)} H{-}CR_2{-}\overset{+}{C}R_2 + X \\ Y: + H|{-}CR_2{=}\overset{+}{C}R_2 \xrightarrow{(fast)} YH + CR_2{=}CR_2 \end{array}\right\} (E1).$$

With the recognition of these mechanisms, and with full appreciation of their relationship with the substitution processes, the apparently inconsistent observations of the older literature fall into place, and it is possible to make rationally based predictions as to the effect of chemical constitution and physical conditions on the phenomenon. Special interest is attached to the analysis of the factors governing the contrary tendencies implied in two well-known empirical rules, namely, the Hofmann and Saytzeff rules, which indicate the preferred direction of olefin elimination in alkyl 'onium salts and in branched-chain alkyl halides respectively. (The Hofmann rule refers to the preferential formation of that ethylene which bears the smallest number of alkyl groups; Saytzeff's rule, on the other hand, predicts the production of the most alkylated of the possible alkyl ethylenes.) It is found that bimolecular 'onium salt reactions are subject to the Hofmann rule, while the bimolecular reactions of halides, and the unimolecular reactions of both 'onium salts and halides, are governed by the Saytzeff rule. Furthermore, the Hofmann and Saytzeff influences are shown to be manifestations of the operation of the inductive and electromeric effects, respectively, of alkyl groups (compare preceding paragraph); for example:



$$H_3C{-}CH_2{-}CH{=}CH_2 + H_2O + NMe_3$$

The inductive effect of the $\beta$-methyl group *inhibits* the removal of a $\beta$-proton (Hofmann influences).



$$H_3C{-}CH{=}CH{-}CH_2 + H_2O + \bar{C}l$$

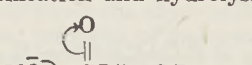
The electromeric effect of the $\beta$-methyl group *facilitates* the removal of a $\beta$-proton (Saytzeff influences).

The theory of aliphatic substitution can also be applied to the problem of carboxylic esterification and hydrolysis[5]. In this instance, it is necessary, in the first place, to distinguish between 'basic' reactions (hydrolysis in neutral or alkaline solutions) and 'acidic' reactions (acid-catalysed hydrolysis and esterification). In the former the carboxylic entity which suffers reaction is $R'.CO_2R$, while in the latter it is $[R'.CO_2HR]^+$. (In general, hydrolysis and esterification may be treated similarly; in esterification ($R = H$), however, the basic reaction is suppressed.) Secondly, there are two distinct modes of bond-fission, namely, 'acyl-oxygen fission' and 'alkyl-oxygen fission'; and, in both basic and acidic reactions, either the one or the other may take place according to circumstances. There are thus four main types of reactions, which, with respect to the carboxylic entity and its mode of fission, may be represented:

| | Basic Reactions | Acidic Reactions |
|---|---|---|
| Acyl-oxygen fission: | $R'.CO\|{-}O{-}R$ | $[R'.CO\|{-}OH{-}R]^+$ |
| Alkyl-oxygen fission: | $R'.CO{-}O{-}\|R$ | $[R'.CO{-}OH{-}\|R]^+$ |

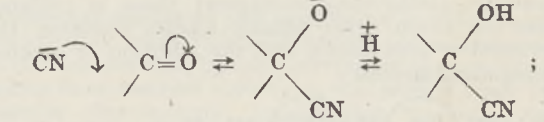
In esterification ($R = H$), there is a corresponding fission in the alcohol, that is, $R{-}O{-}|H$ (in acyl-oxygen fission) and $R|{-}O{-}H$ (in alkyl-oxygen fission). Finally, it would appear, from the rather limited amount of suitable kinetic data, that, for certain of these reactions, two mechanisms exist which are related to each other just like the unimolecular and bimolecular mechanisms of simple nucleophilic substitution.

As in certain of the reactions involved in carboxylic esterification and hydrolysis, for example,

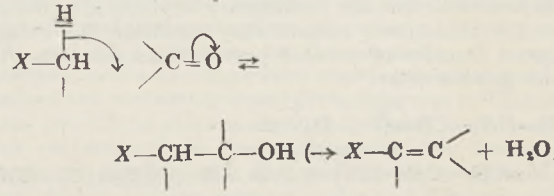


$$HO{-}CR'|{-}OR \longrightarrow HO{-}C.R' + \bar{O}R,$$

the addition and condensation reactions of carbonyl compounds[6] are dependent on the reactivity, towards nucleophilic reagents, of the carbon atom of the carbonyl group. A simple example is to be found in cyanohydrin formation, the mechanism of which was clearly indicated by Lapworth's classical kinetic investigations:



while reactions of the Aldol, Claisen, Knoevenagel and Perkin type follow a similar, though somewhat more complex, plan, for example:



$$X{-}CH{-}C{-}OH \; (\rightarrow X{-}C{=}C< + H_2O).$$

The Michael and the Thorpe reactions typify a quite analogous addition of a nucleophilic reagent to suitably activated C=C and C≡N bonds respectively.) All these reactions have certain features in common; thus they generally exhibit both alkaline and acid catalysis, and, while one of the reactants is a carbonyl compound, the second component contains a labile hydrogen atom which is activated by at least one electron-attracting substituent ($X$). The function of the basic catalyst is to remove the proton, thereby creating a more powerful nucleophilic reagent, and there is kinetic evidence that this reaction may, in certain cases, constitute the rate-determining stage of the process. An acid catalyst, on the other hand, probably activates the carbonyl component by forming an oxonium complex, $>C=\overset{+}{O}H$. Reactions of the type of the acetoacetic ester condensation are also similar, and the analogy with the alkaline hydrolysis of esters is even more striking in this case:

$$(CO_2Et).CH_2 \cdot CMe|—OEt \longrightarrow Me.CO.CH_2.CO_2Et + EtOH.$$

The protropic changes of carbonyl compounds[7], like the reactions discussed in the preceding paragraph, are catalysed both by bases and by acids. In terms of the ionic theory of prototropy, this circumstance is easily explained, for, according to this theory, the change involves the removal of a proton and the addition of a proton, processes which will obviously be facilitated by bases and by acids respectively. In the base-catalysed reaction, it is generally accepted that the first step involves the transfer of a proton to the catalyst, a 'mesomeric' anion being produced, which, by accepting a proton (for example, from the medium or the conjugate acid of the base), can form either the one or the other component of the tautomeric system:

$$\bar{B} + H|—CR_2—CR=O \rightleftarrows$$

$$B.H + [R_2C=CR=O]^- \rightleftarrows R_2C=CR—O—|H + \bar{B}.$$

The equality of the rates of halogenation, of protium-deuterium exchange and of racemization, which has been demonstrated for certain ketones (asymmetric at the α-carbon atom), thus receives a simple interpretation if it be assumed that the rate-determining stage in all these reactions is the formation of the mesomeric anion. Similar ideas can be applied to other prototropic systems, but in certain cases (for example, methyleneazomethines) there is evidence that the anion never attains kinetic freedom, the removal of one proton and the addition of another being simultaneous:

$$\bar{B} \cdot H|—CR_2—N=CR_2' \cdot H|—B \rightleftarrows B—|H \cdot CR_2=N—CR_2'—|H \cdot \bar{B}.$$

In acid catalysis, the preliminary addition of a proton to the tautomeric system may facilitate the subsequent transfer of another proton from the latter to the solvent ($S$):

$$H—CR_2—CR=O + H.\overset{+}{S} \rightleftarrows$$

$$[H—CR_2—CR—OH]^+ + S \rightleftarrows \overset{+}{S}.H + CR_2=CR—OH.$$

Alternatively, the proton addition and elimination may take place simultaneously:

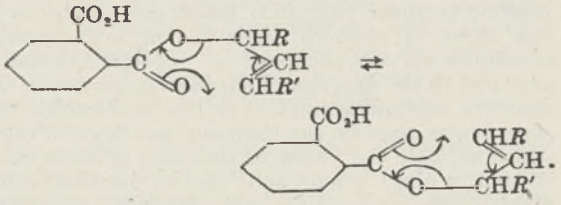
$$S \quad H|—X—Y=Z \cdot H|—\overset{+}{S} \rightleftarrows \overset{+}{S}—|H \cdot X=Y—Z—|H \quad S.$$

Anionotropic change[8] is, in some respects, similar to prototropic change, and it is also related to nucleophilic substitution. In anionotropy we are concerned with the movement of negative groups, and there is evidence that the interconversion may proceed through the intermediate formation of a positive mesomeric ion and a complementary negative ion; for example,

$$R.\overset{X}{\overset{|}{C}}H—CH=CHR' \rightleftarrows [R.CH\cdots CH\cdots CH.R']^+ + \bar{X} \rightleftarrows R.CH=CH—\overset{X}{\overset{|}{C}}H.R'.$$

$$(.X = .Hal., .OH, .OR, .O.CO.R, \text{etc.})$$

It has been shown that the mobility of the system is increased by the following factors: (1) Strong electron-affinity in the group $X$, (2) large electron-release from the group $R$, (3) high ionizing capacity in the medium. These are the relationships to be expected if ionization is involved, and it will be recalled that the same factors assist the ionization mechanism of nucleophilic substitution ($S_N1$). All the facts relating to the phenomenon cannot, however, be explained on the basis of this mechanism alone. It has been shown, for example, that the anionotropic rearrangement of optically active hydrogen phthalates of substituted allyl alcohols is often accompanied by a high degree of retention of optical activity, and an intramolecular mechanism has been suggested to account for this and similar observations:



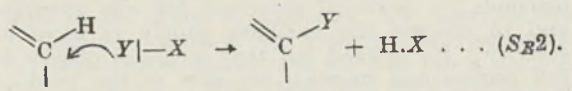
In the study of the kinetics and mechanism of ring-closure[9], the reactions which have yielded the most profitable results are mainly those which involve an internal nucleophilic substitution; for example:

$$(CH_2)_n\begin{matrix}NH_2\\CH_2—Br\end{matrix} \rightarrow (CH_2)_n\begin{matrix}NH\\|\\CH_2\end{matrix} + HBr.$$

Since the intermolecular processes which generally accompany the cyclization involve two such molecules, and are therefore of a higher order, the best yields of cyclic derivatives are obtained in dilute solutions. This principle has been widely exploited both in synthetic work and in the simplification of kinetic experiments. The most important aspect of this subject concerns the effect of homology, and of the notable results which have been obtained in this connexion perhaps the most interesting relate to the great ease of formation of three- and five- (but not four-) membered rings, the special difficulty of forming rings of about nine to eleven atoms, and the

alternation between odd- and even-numbered structures which is clearly exhibited in the higher members. The factors responsible for these effects are obviously rather complex, but the two most important are probably the 'distance' and 'strain' factors of Ruzicka's well-known theory, the former assisting the cyclization of short chains, and the latter favouring the formation of strainless rings.

In the replacement of hydrogen in the aromatic nucleus[10], we have a clear example of electrophilic substitution, and, since the attack of the reagent is an essential condition for the expulsion of the displaced atom (mechanism $S_E2$), the reaction rate will depend primarily on the electrophilic activity of the reagent and the electron availability at the reaction centre :



Concerning the reagent, it has been suggested that the efficacy of a halogenating or nitrating agent, $X.Y$ ($Y$ = Hal. or $NO_2$), increases with the electron affinity of $X$ (as indicated, for example, by the acid-strength of H.$X$); for example, Cl.Br > Br.Br > HO.Br; $SO_4H.NO_2(a) > H_2\overset{+}{O}.NO_2(b) > AcO.NO_2(c) > HO.NO_2(d) > \overline{O}.NO_2(e)$. The predicted sequence of brominating agents has been confirmed experimentally, and the order with respect to nitration is consistent with the assumption that the reagents mentioned are effective when the reaction is carried out in sulphuric acid (*a*), sulphuric acid or fuming nitric acid (*b*), acetic anhydride (*c*), acetic acid (or similar inert solvent) (*d*), and water (*e*).

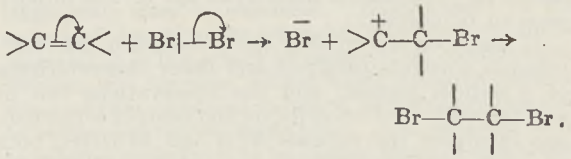
A consideration of the second factor, namely, the electron availability at the reaction centre, must take into account the 'directing' influence of a substituent group with respect to further substitution. Numerous experimental investigations and theoretical arguments concerning this problem have led to a conclusion which may be broadly summarized in the following statement : Electron-releasing groups (for example, . $CH_3$) or electron-attracting groups (for example, . $NO_2$, . $CO_2Et$) increase or decrease, respectively, the electron availability (and, consequently, the reactivity towards the electrophilic reagent) in all the nuclear positions, but more so in the *o*- and *p*-positions than in the *m*-position, the former groups therefore leading to a predominating *o*,*p*-substitution and the latter to *m*-substitution. This is well illustrated by the relative partial rates of nitration, for the various positions in benzene, toluene and ethyl benzoate, tabulated below :

| | Ortho | Meta | Para |
|---|---|---|---|
| $C_6H_5$.H | 1 | 1 | 1 |
| $C_6H_5$.$CH_3$ | 43 | 3·0 | 55 |
| $C_6H_5$.$CO_2$Et | 0·0026 | 0·0079 | 0·0009 |

(These 'partial rate factors' are obtained by combining the figures for the total rates of nitration of the mono-substituted compounds relative to benzene (determined by a 'competition' method) with the proportions of isomerides formed.) In the chlorination of certain phenolic ethers, it has been shown that the effects of substituent groups on the reaction rate are reflected in approximately equivalent changes in the Arrhenius critical energies, and this important result has since been observed for several other reactions.

General experience relating to the effect of nuclear substituents on the Friedel-Crafts reaction[11] supports the view that it may be regarded as another example of the type of substitution discussed in the preceding paragraph. (Compare, for example, the inhibitory effect of nitro-groups ; and the difficulty of avoiding polyalkylation during attempted monoalkylation (activation by alkyl substituents), contrasted with the fact that no similar difficulty attends mono-acylation (deactivation by acyl substituents). Apparent anomalies in the orientation of the substitution can be satisfactorily explained on the basis of the interconversion of products which is known to occur in the presence of the metal halide catalysts. The formation of abnormal proportions of *m*-derivatives in the alkylation of alkyl benzenes, for example, illustrates the tendency to form the product in which the activation of one alkyl group by the other is least, that is, the most stable isomer.) The most interesting aspect of the reaction concerns the effect of the catalysts employed, of which the most common are the halides of boron, aluminium and iron. It is now widely accepted that the most important function of the catalyst is to increase the electrophilic activity of the substituting agent by the conversion, through complex formation, of a mainly covalent carbon-halogen bond into one of essentially ionic character : $R{:}\ddot{\underset{\cdot\cdot}{Cl}}{:}\curvearrowright AlCl_3 \rightarrow R^+[AlCl_4]^-$. Substantial evidence in favour of this interpretation has been obtained by conductivity, dielectric polarizability, and radio-isotopic exchange measurements in solutions containing the organic and inorganic halides. The electron deficiency in the alkyl component of the complex should favour the formation of secondary rather than primary, and tertiary rather than secondary, derivatives, thus accounting for the rearrangement of the alkyl group which is frequently encountered in the Friedel-Crafts reaction.

Addition to olefinic compounds[12] is related to electrophilic substitution, for, in the normal course of events, the reaction is initiated by the attack of an electrophilic reagent on the unsaturated carbon atom at which the electron density is highest. In the thermal addition of halogen in certain dissociating solvents, for example, it is well established that the following two-stage mechanism is involved :



Evidence in favour of this mechanism is afforded by the effect of substituents of known polar character on the reaction rate, by the intervention of extraneous anions or a reactive solvent in the second stage of reaction (for example, bromohydrin formation in aqueous solution), and by the stereochemical data. It may be expected to function in its simplest form in dissociating solvents only, and this is confirmed by the experimental results. In non-dissociating solvents, and in the gas phase, the thermal halogenation is highly sensitive to the presence of stray catalysts, and a heterogeneous reaction involving the walls of the containing vessel often intervenes. Under these conditions the reaction is obviously very complex, and some of the observations may even indicate an atomic mechanism. The gaseous photo-addition undoubtedly involves neutral atoms and free radicals

(*cf.* following paragraph), and this may also be true of the corresponding reaction in solution :

$$X_2 + h\nu \rightarrow 2X. \; ; \quad >C{=}C< + X. \rightarrow >\dot{C}-\dot{C}-X$$

$$>\dot{C}-\dot{C}-X + X_2 \rightarrow X-C-C-X + .X.$$

Homolytic reactions involving free radicals[13] (compare Table of Types of Substitution) exhibit some similarity to the heterolytic processes in which electrophilic reagents are concerned, because free radicals generally have depleted electron shells and tend to share an extra electron : for example, $C_6H_5. + Cl-CCl_3 \rightarrow C_6H_5-Cl + .CCl_3$. Their electrophilic character is most clearly shown in the addition reactions with olefins. In the so-called 'normal' addition of hydrogen bromide to the alkylethylenes, the proton adds preferentially to the unsaturated carbon atom bearing the smaller number of alkyl groups (cf. Markownicoff's rule), for example,

$$(CH_3)_2C{=}CH_2 + H|-Br \rightarrow$$

$$(CH_3)_2\overset{+}{C}-CH_3 + \overset{-}{Br} \rightarrow (CH_3)_2C(Br).CH_3.$$

Likewise, in the peroxide-catalysed reaction ('abnormal' addition), the addition is initiated by the attack of a bromine atom at the point of higher electron density :

$$(CH_3)_2C{=}CH_2 + .Br \rightarrow (CH_3)_2\dot{C}-CH_2Br \xrightarrow{HBr}$$

$$(CH_3)_2CH-CH_2Br + .Br.$$

It must be emphasized, however, that this analogy between neutral radicals and electrophilic reagents has definite limitations. Thus, it is well known that aromatic substitution reactions of neutral radicals, for example, $Ph. + H.C_6H_4R \rightarrow Ph.C_6H_4R + .H$, do not exhibit the usual orientation effects associated with the heterolytic reaction. This is understandable, for the 'orienting' influence of a substituent group is due to its transmitted polar effects, which are largely dependent on the demands of the reaction involved, and it is reasonable to suppose that the electron displacements which are a necessary condition for an oriented heterolysis are of less importance in homolysis.

It has been shown that the Cannizzaro reaction[14] exhibits peroxide catalysis and other characteristics of a radical process, and the observations can be satisfactorily accounted for on the basis of a mechanism involving the radicals *R*CO and *R*CHOH, both of which are formed from the aldehyde *R*CHO by univalent oxidation and reduction respectively.

## USE OF SCIENCE AND SCIENTIFIC WORKERS IN THE WAR

THE sessions during the morning and afternoon of the last day of the Conference organized by the Association of Scientific Workers and held in London during January 10–11 dealt with the two related topics : the utilization of scientific personnel, and the application of scientific knowledge to production and Services problems.

After an introductory address by Prof. S. Chapman, in which he compared the use of science in the War of 1914–18 and in this War, Prof. W. Wardlaw spoke on the working of the Central Register. He stated that the Register has come in for a good deal of criticism but that it should be borne in mind that nearly all the persons enrolled on the Register are already in useful work from which they can only move to more important posts. The Register is intended to be a complete record of the higher administrative, professional and technically qualified personnel of Great Britain, whether employed or not. The number of engineers and scientific workers on the Register has risen from 65,000, in May 1940, to 167,000, in December 1941. It has never been the function of the Register to determine how scientific and technical knowledge should best be used in the prosecution of the War ; its purpose is to meet demands for technical personnel for war purposes and to allocate the available supply in cases of scarcity. He pointed out that technical officers of full professional standing are now at the head of each section, and referred to the formation of the Technical Personnel Committee under the leadership of Lord Hankey.

Prof. Wardlaw then dealt with the new procedure of progressive de-reservation being conducted by the District Manpower Boards of the Ministry of Labour. He stated that steps are being taken to ensure that anyone with technical qualifications of Central Register standard, if not already deferred by virtue of his work, will be dealt with by the Register and placed in work which makes full use of his technical capacity, whether in the Forces or not.

Mr. E. D. Swann, of the executive committee of the Association of Scientific Workers, presented the results of inquiries by the Association into the position in the main industries in the country. It has been found that many scientific workers and engineers are not being used on war work but are engaged instead on development and design for the period of post-war competition. Others who are nominally engaged on war work have insufficient to occupy their time fully. He stated that the Essential Works Order is being used to hold redundant staff, that no mechanism exists for providing partly occupied laboratories with further problems, and that there is considerable duplication of work in laboratories and design departments of similar undertakings. He pointed out the need for provision for the proper pooling of information, including trade secrets. Another weakness is the notable lack of contact between the design departments of the Ministries and the design and production departments in industry. It has been found that criticism of designs from the point of view of speed and economy of manufacture is not encouraged. The Association has collected enough evidence of this sort to press for an investigation into the utilization of our technical resources by the Select Committee on National Expenditure.

Mr. Swann then dealt with the Association's proposal that a Technical Planning Committee should be set up under the Production Executive. This Committee would deal with the technical resources of Great Britain in the same manner as the existing Industrial Capacity and Materials Committees deal with their respective resources. In this scheme it is essential that this Committee be given executive powers. The Association of Scientific Workers, as it is composed of working men of science and technicians, is in a position to know how effective is the present organization in practice, and it knows that it is not

working satisfactorily. Central planning of scientific work is essential, and scientific committees must have contact with working men of science on the job.

The position inside the Services was considered by two speakers at some length. Prof. H. Levy stressed the vital importance of having trained men of science inside the Armed Forces. He wants to see scientific men actually at the front who could bring back all kinds of relevant information of a technical nature. He pointed out that in Great Britain scientific education is not considered in selecting personnel for the higher commands. He stressed that not only military men should be chosen, but also scientific men who have had knowledge and experience of military matters.

Mr. F. Morgan, an operational research scientist attached to an R.A.F. command, provided a first-hand review of this type of work. He described how a number of workers are drafted from research to battle centres to ensure that the best use is made of their inventions. Now these men have acquired an operational outlook and can tell their research establishment what the Command most needs; that is, they can initiate research on new equipment and suggest modification to existing equipment. But their most useful function lies in helping Command to make the best use of equipment provided. This involves education of the people who use it, statistical analysis of the ways in which it can be used, and general investigation and the arrangement of tests. He pointed out in the second connexion that his Command now analyses everything numerically from efficiency of weapons to comparison of tactics. As a result, scientific workers are able to suggest and invent manœuvres—they are no longer "amateur strategists".

Mr. Morgan emphasized the importance of methods of communication in this War, and stated that automatic equipment has not been exploited as it should. He illustrated how in the problem of night fighting, mathematicians, physicists, biochemists, psychologists and physiologists are all needed. He hopes that there will be a permanent place in the Services for such scientific field work, and suggested the formation of a central research body for all the Services, and a greater measure of inter-Service liaison. It was significant that he pointed out from the other side the tenuous connexion between operational and industrial scientific workers. Further, he asked for closer contact with their colleagues in all Allied countries. His was a thoughtful paper which made a deep impression on the Conference. In pointing out the not inconsiderable risks which this type of work involves, he expressed the grievance that there is no special compensation for dependants in the event of casualties sustained on flying duties and that promotion is slow relative to the Service rate.

A most refreshing contribution was that of Mr. T. Halse, of the Industrial Committee of the Association. After citing several of the more extreme instances where the present lack of planning has led to marked inefficiency, he dealt with the ways in which the scientific worker in industry could help better the situation. Most important of these is participation in Production Committees, whether actually in the factory or regionally. He underlined the need for the scientific workers themselves to be organized to get the best results in this direction.

There were numerous papers in which were instanced in detail and from first-hand experience bad examples of misuse or inefficient utilization of technical knowledge. Mr. R. E. Foster reported that in his laboratory, which is attached to a large aero-engine factory, most of the work consists in re-checking materials which have already been subjected to Air Ministry inspection and release. There is also a considerable amount of slack time in his laboratory, although members have been refused their release on the grounds of pressure of work. When dealing with the position in the research department of this firm he mentioned that there is insufficient allocation of funds for new equipment, lack of space, and inadequate pay for the research staff. He and his colleagues believe that production is being severely handicapped by lack of scientific planning and management, and by lack of co-operation between management and staff, and between staff workers and manual workers. Continuing, he suggested remedies, emphasizing the part of Production Committees, and calling for the national pooling of all resources of development and research and full interchange of all experimental and production data, regardless of vested interests.

The present situation in the chemical industry was considered by Mr. A. Dooley. Whereas the engineering industry is mainly based on mass-production methods, the chemical industry demands the existence of *teams* of workers, embracing manual, scientific and clerical workers. There should be no arbitrary breaking up and re-assembling of such groups, and replacement personnel should be specially trained to maintain the efficiency of the group as a whole. We can expect that the extension of the War will create a demand for substitute products and the reclamation of used material on a large scale. This will bring into active war production sections of the chemical industry which have been kept more or less in reserve.

Mr. Dooley dealt especially with the rubber situation. At the moment, in Great Britain, we reclaim only one fifth of the proportion reclaimed in the United States, and an American authority has estimated that it would take 18–24 months to construct new plants. Our capacity for synthetic replacement manufacture appears to be negligible, but we could draw on the extensive experience of the United States and the U.S.S.R. Dove-tailed planning would be necessary, and electric power on a large scale may be essential. With regard to the technical development of substitute and reclaimed material, it is important to ensure close collaboration between the Services, rubber users, research associations and the chemical industry, and this applies also to resins and textile substitutes. The problem is on too large a scale for it to be carried through effectively by haphazard methods.

A notable set of contributions were those which dealt with the protection of the health of the industrial worker. Dr. T. O. Garland in a forceful speech directed attention to the comparative indifference with which many managements have treated this question in peace-time. Recently the British Medical Association has issued a report which advocates medical supervision of workers in every factory, large or small, which should aim at reducing the general sickness rate as well as the accident rate. Dr. Haden Guest has stated that the number of medical men in industry is a very small proportion of those in the Services. Dr. Garland asked for medical men to be called up into industry as well as into the Forces. With the building of large munition factories the situation is aggravated, because the general practi-

tioner service is not sufficient to cope with this extra work. Dr. R. O. Stanford supported this suggestion, quoting from his own experience as a medical officer at a large factory. He sketched a plan for mass-radiography of workers in order to diagnose the early stages of tuberculosis, a disease which is on the increase. Dr. D. McClean, of the Lister Institute, stressed in this connexion that all milk sold to the public should be *safe* (that is, not infected) milk.

The Oxford vaporizer, a simple apparatus for administering anæsthetics under battle conditions, was described by Dr. K. Mendelssohn, of the Clarendon Laboratory, Oxford. This vaporizer is now being mass-produced at a cost four times lower than that if bench-produced. He stressed the need for closer contact between medical men and men of science, between clinical and laboratory workers.

Dr. S. E. Hollingworth, of the Geological Survey, illustrated how geologists are often not called in when sites for factories, camps and air-raid shelters are decided upon. This has led to considerable waste when the site is badly chosen in relation to drainage and water-supply. Dr. N. F. M. Henry, of the Department of Mineralogy, Cambridge, asked for a larger place in the war effort for geologists, stating that the British Army has only two geologists. He also discussed the Malayan situation and the consequent need for using the other mineral resources of the Allied countries.

There were many other speakers in the discussions, and they represented between them a considerable cross-section of industry. Mr. F. M. H. Markham, of the Central Register, answered some of their points regarding the utilization of personnel. Although he mentioned some cases where action is being taken or being considered, the Conference seemed quite definitely to show the need on the part of official committees for consulting the junior scientific worker.

The Conference was summed up most ably by Prof. J. D. Bernal. Starting on a note of urgency, he appealed for an absence of complacency on the part of men of science with regard to what Great Britain is doing. The suggestions which were put forward at the Conference would be taken up with the Ministries of Supply and Labour, but this would not be done without opposition. This opposition would come from industry and from the Government. The first is due to the prevalence of pre-war competitive ideas, while the second is purely conservative opposition to new ideas. However, the scientific way of doing things is forcing its way against that opposition, although the attitude in many of the departments is equivalent to sabotage. Dealing with the proper utilization of our man-power, he emphasized that the only consideration in the selection and posting of personnel should be ability. We should be blinding ourselves to facts if we thought this was so at present. He referred to the contributions in the Conference which had shown a widespread feeling that these scientific workers are not fully occupied, not doing the work they can most usefully do. The mechanism that exists at present is certainly not adequate if this situation holds. The Conference is not passing any resolutions ; it is instead going to take appropriate action. The Association of Scientific Workers will collate the information and suggestions, and send delegations to appropriate Ministries. Scientific workers are at last co-operatively conscious of the job they have to do in society, and they will do it, and not stop doing it, when the War is won.

# OBITUARIES

## Dr. Walcot Gibson, F.R.S.

THE death of Walcot Gibson will recall to many the memory of a many-sided, alert and virile personality. Born in 1864, he went from Bromsgrove School to Mason College (now the University of Birmingham) at a time when Lapworth, fresh from his triumphs in the south of Scotland, had been appointed to the chair of geology. Young Gibson, his first student, fell under the master's spell and his admiration for Lapworth remained with him as an inspiration throughout his career.

Following on a course of study at the Royal College of Science, Walcot Gibson undertook private geological work in South Africa during 1889–91 and in East Africa during 1891–93. The rest of his active life was spent in Great Britain in the service of the Geological Survey. Appointed temporary assistant geologist in 1893, he became geologist in 1901, district geologist in 1913, and in 1920 assistant director in charge of the Survey work in Scotland. In 1925 he retired and elected to live at Hythe, where he found leisure and opportunity to indulge in his love of gardening and painting. One of his chief pleasures was to welcome his old friends and former colleagues to his new home, and none who visited him but left with an increased regard for his sanity of outlook and balanced judgment on scientific matters. Soon after the outbreak of war he had to leave Hythe, and he died in Cambridge on November 28.

Walcot Gibson was part author of numerous Geological Survey memoirs dealing with the structure, succession and economic resources of many important coalfield areas in the Midlands and in South Wales : for example, Stoke-on-Trent (1902, with second editions in 1905 and 1925), North Staffordshire (1905), South Derbyshire and Nottinghamshire (1908), North Derbyshire (1913), South Staffordshire and Warwick (1919), Abergavenny (1902), Pontypridd (1903 and 1917), and Merthyr Tydfil (1904). He had learnt from Lapworth the necessity for careful and exact mapping and the value of what his exemplar termed the "zonal method of stratigraphy". He applied these lessons with scrupulous care to his studies of the detailed stratigraphy and palæontology of the Midland coalfields, and through his published works and the many personal contacts he made in the mining world he played an important part in guiding their economic development. A notable achievement in this direction was his study of the "Concealed Coalfield of Yorkshire and Nottinghamshire" (1913).

While much the greater part of Gibson's work was of an intensive, detailed character which perhaps only the specialist can fully appreciate, he won for himself many warm admirers among a wider public by the publication in 1920 of his book on "Coal in Great Britain". In this volume he brought together in a compact and attractive form the essential information regarding the British coalfields, and its success in filling a long-felt want may be gauged by the fact that a revised and enlarged edition appeared in 1925.

Walcot Gibson's services to science, particularly in the field of economic geology, were recognized by the award in 1924 of the Murchison Medal of the Geological Society and in 1925 by his election to the fellowship of the Royal Society.

M. MACGREGOR.

## Prof. S. G. M. Ure

PROF. S. G. M. URE, whose death at the age of sixty occurred on December 25, was widely known as one of the pioneers of chemical engineering education in Great Britain. Born in 1881, he attended Allen Glen's School and later graduated at the University of Glasgow, where he took the degrees of B.Sc. in engineering and M.A. in mathematics and physics. On leaving the university he spent five years in the shipbuilding industry before taking up the educational work to which, with one short interval, the remainder of his career was devoted.

To those who were actively concerned with the vast production programme of the War of 1914–18 the difficulties which arose through the lack of trained scientific personnel made an abiding impression. They determined that, with the return of settled conditions, a concerted effort should be made to introduce into our universities a form of training which would produce men having the qualifications necessary to ensure the development of chemical industry on sound progressive lines. The names of Lord Moulton, Sir Arthur Duckham and Prof. Hinchley will long be remembered in this connexion ; and, first as assistant to Hinchley, later as his successor, Prof. Ure took a notable part in the crusade.

In 1921 Ure was appointed lecturer in chemical engineering at the Imperial College of Science and Technology and in the following year he became a founder-member of the Institution of Chemical Engineers. From then until his death his energies were devoted unsparingly to the cause of chemical engineering training and to the service of the new Institution.

In 1932 he succeeded Hinchley as assistant professor of chemical engineering in the Imperial College, and in 1937 he was closely associated with the framing of an undergraduate course in the subject.

Ure was associated with many scientific activities. He was first elected to the Council of the Institution of Chemical Engineers in 1928 and became a vice-president in 1937 ; he served on numerous committees of the Institution and for ten years was editor of its *Transactions*.

D. M. NEWITT.

## Dr. J. S. Owens

THE death of Dr. J. S. Owens on December 6 removes a most useful and public-spirited man of science. For nearly thirty years Dr. Owens has been the moving spirit in the investigation of atmospheric pollution on its quantitative side. He devised the instruments in use, and co-ordinated, tabulated and prepared for publication all the data on which the progressive changes in the amount of pollution in the atmosphere are evaluated.

Owens was born at Enniscorthy, Co. Wexford, Ireland, on July 28, 1871. He took the M.D. degree at Trinity College, Dublin, in 1896, but soon gave up medicine for engineering. He was a successful civil engineer chiefly in connexion with sea defence works and mining, and became consulting engineer to the San Domingo Mines in Portugal, and the Rio Tinto Copper Mines in Spain.

As the result of the Smoke Abatement Exhibition in 1912 a committee was formed for the systematic investigation of atmospheric pollution, and Owens became its secretary. In 1917 the work of this committee was transferred to the Meteorological Office and Owens was appointed part-time superintendent in charge of the Atmospheric Pollution Division. In 1927 the Department of Scientific and Industrial Research took over the investigation of atmospheric pollution from the Meteorological Office, and in order that the supervision of the instruments and the compilation of statistics should remain in his charge, Owens was appointed superintendent of observations.

For the quantitative investigation of atmospheric pollution Owens devised three main instruments and several instruments of lesser importance. The most widely used of these instruments was the standard deposit gauge. This consisted of a simple collecting basin having an opening of approximately four square feet exposed in the open on a stand at a height of four feet.. All the pollution and rain which fell into the basin was collected and analysed, giving valuable information as to the amount and nature of the pollution deposited from the atmosphere. The second instrument was the automatic filter gauge for determining the amount of pollution contained in a given volume of air, and the third the jet dust-counter, for counting the number of particles of soot and other insoluble particles contained in the air. All three instruments have performed invaluable service, 123 deposite gauges and 16 automatic filters being maintained by municipalities and other public bodies in 1938.

Owens's inventive skill, conscientious compilation of records and personal enthusiasm have resulted in Great Britain being far ahead of any other country in knowledge of the pollution of its atmosphere—in this he has performed a valuable public service. Three days before his death Owens was awarded the Symons Gold Medal by the Royal Meteorological Society "for distinguished work done in connexion with Meteorological Science".

## Mr. R. S. Herries

ROBERT STANSFIELD HERRIES died in December last at the age of eighty-one years. He took an active part in the work of the Geological Society, of which he was secretary from 1897 until 1905, and treasurer from 1921 until 1929 ; and of the Palæontographical Society, of which he was treasurer from 1914 until 1938. He was president of the Geologists' Association during 1906–8, and contributed the section on East Yorkshire to "Geology in the Field" published by the Association. Herries collaborated with the late H. W. Monckton in research on the Bagshot Beds of the London Basin. His geological collection (including the one made by his brother, the late Sir W. H. Herries) was presented to the Sedgwick Museum, Cambridge, with the exception of fossils from the Yorkshire coast, which he gave to the Yorkshire Museum, York.

WE regret to announce the following deaths :

The Right Hon. the Earl of Berkeley, F.R.S., on January 15, aged seventy-six.

Dr. C. Delisle Burns, formerly Stevenson lecturer in citizenship in the University of Glasgow, on January 22, aged sixty-two.

Prof. R. S. Seton, emeritus professor of agriculture in the University of Leeds, on January 12, aged seventy-four.

# NEWS and VIEWS

## Science and the Classics

WE had thought that the old controversy between science and the classics had been finally disposed of, but a resolution submitted on January 22 to the Lower House of Convocation of Canterbury came perilously near raising it once more. The resolution was moved by Dr. E. G. Selwyn, dean of Winchester, who urged that the revival of classical education is necessary for the good of the Church and of the nation. The classical outlook, in his view, stands for humanism, which includes the belief in absolute standards of conduct and in individual personality. Classics must, however, be made less specialized, and more room must be found for science. On the other hand, it must be recognized by science that concentration on material things imposes certain limitations. Thus in Dr. Selwyn's view, although modifications in the classical type of education are desirable, science would be admitted almost as a poor relation, presumably in deference to the needs of the times.

While no broad-minded man of science would wish to deny that an educational system based on science alone has very definite shortcomings, it is surely out of the question to suggest that any useful purpose can be served by relegating science to a subordinate position in twentieth-century studies. Science and the classics both have a place in modern culture, but should competition arise, it is to be expected that science should be given the greater share of attention. Dr. W. R. Matthews, dean of St. Paul's, discussing the resolution, emphasized that scientific studies have provided openings for many minds not naturally able to profit by classical studies, and pleaded for an all-round education including science. Eventually, the original resolution was modified and carried, with two dissentients, in the following form: "That this House, while recognizing the great value of scientific and other modern studies, is of opinion that wider recognition of the importance of classical education is urgently needed in the interests of the Church and nation and for the maintenance of a stable civilization and culture after the war."

## *Endeavour*

Imperial Chemical Industries, Ltd., has just issued the first number of a new quarterly journal, *Endeavour*, which is designed to record the progress of the sciences in the service of mankind and as evidence of British scientific enterprise. The issue, which is priced at 5*s*., is well produced, carrying forty-eight pages of text, and well bound, with a drawing on the cover of the barque *Endeavour* which, commanded by Captain Cook, was sent out in 1768 by the British Admiralty to chart the South Pacific Ocean and observe the transit of Venus. After a brief statement by Lord McGowan of the purpose of the new journal, the number opens with a short article on "Science and the Community" by Sir William Bragg. The main feature of this initial number is Dr. H. Spencer Jones, the Astronomer Royal, on the "Distance of the Sun". Other articles are equally as authoritative, as may be judged from the following selection: Dr. C. H. Waddington, "The Epigenotype"—the author's name for the whole complex of development processes which lie between genotype and phenotype; J. G. Crowther, "Sciences in the U.S.S.R."—though the author confines himself to the physical sciences; we suggest that this be followed by one on the biological, agricultural and medical sciences, for which the world has much to thank the U.S.S.R.; A. L. Bacharach, "The Manufacture and Use of Vitamins"—in which emphasis is placed on British contributions to this important branch of science; G. V. Jacks, "Prospects for Soil Conservation"; F. Fairbrother, "The Cyclotron"; etc.

The edition of *Endeavour* before us is in English. There are to be other editions in Spanish, French and German, and a total distribution of 25,000 copies is contemplated to be sent to colleges, scientific institutions, universities and prominent individuals in foreign countries and the British Empire. The influence of the journal will therefore be much more than national, and we warmly welcome it since, as Sir James Jeans says in a communication, it "will help to make the beneficent advances of science the common property of all nations and of all races". As Lord McGowan points out, *Endeavour* will help to throw the light of science overseas especially to those parts of the globe where intimate contact with Great Britain is at present more difficult to maintain. Emphasis is laid on British scientific work, but as Lord McGowan says, the journal will not be marked by any narrow insularity, as is sufficiently guaranteed by the contents of this inaugural number. We congratulate the editor and Imperial Chemical Industries, Ltd., on this remarkably attractive and efficient achievement and wish it the success which its cause so richly deserves.

## Wealden Iron Ore

IT is well known, as was recently mentioned in a letter in *The Times*, that iron ore occurs in various parts of the Weald, where mining and smelting were carried on by the Romans, and were continued until the nineteenth century. Smelting ceased in 1828, and mining in 1858. The Wealden iron industry was highly decentralized, and consisted of a large number of small works. It bears no comparison with that of modern times. E. Straker, in his book "Wealden Iron" (1931), lists more than 225 furnaces, forges and bloomeries spread in time over several centuries. The life of many of these was short. The largest works were at Ashburnham; of these, Mr. Straker records that the annual output was about 350 tons. Wealden iron ore is usually a clay-ironstone and occurs in nodules and in thin beds up to a maximum of two feet in thickness, interbedded with shale. Sometimes a pale grey sideritic rock is present. The Wadhurst Clay furnished the bulk of supplies, but the other Wealden formations, and also a ferruginous superficial deposit—an ironstone 'pan' or 'shrave'—yielded their quota. Much was mined from bell-pits, which were rarely more than twenty feet deep, although some were upwards of forty feet in depth. Shale excavated with the iron ore was sold as 'marl' for agricultural purposes; indeed, agriculture and iron ore working seem to have gone hand in hand in many instances. Many quarries were opened primarily as 'marl pits', but all ironstone encountered was separated and sold when sufficient had been accumulated.

The last attempt at exploiting Wealden iron was at Snape Mine, Wadhurst, during 1857–58, ore being sent to Staffordshire. Two beds were worked, one up to two feet in thickness. Both beds were irregular in occurrence, sometimes dying out completely for a

distance. The roof was bad, and required timbering. A long account of the Wealden iron industry is given by C. Gould in the Geological Survey Memoir "The Geology of the Weald" (1875), compiled by Topley, and additional information, notably an analysis of the Snape Wood ore, in the Geological Survey's "Special Reports on the Mineral Resources of Great Britain", 12 (1920). This analysis, made in 1908 for J. W. Gregory by Messrs. R. R. Tatlock and Thomson, showed the following, in percentages: FeO, 30·42; $Fe_2O_3$, 10·10; $SiO_2$, 26·10; CaO, 0·86; $SO_3$, 0·06. These show about 30·66 per cent of metallic iron, but the high percentage of $SiO_2$ would prevent the use of this stone as an iron ore. On the contrary, the Ashburnham ore showed FeO, 42·08; $Fe_2CO_3$, 6·85; $SiO_2$, 6·46; CaO, 3·87; $SO_3$, 0·2; giving 37·49 per cent of metallic iron, with relatively little silica. Unfortunately not only are the beds of ore thin, but they are also very irregular in their composition, and there seems little prospect that ore of this kind, which occurs in thin beds and can only be excavated together with a large amount of shale, could be profitably worked by existing methods. The usable reserves of iron ore in the Weald are, in the present circumstances, negligible.

## Awards of the Geological Society of London

THE following awards of the Geological Society of London have recently been announced: *Wollaston Medal* to Prof. R. A. Daly, Sturgis Hooper professor of geology in the Museum of Comparative Geology at Harvard University, in recognition of his fundamental researches in many branches of geology, especially those concerned with the origin of igneous rocks, the constitution of the interior of the earth, and the controls of coral-reef formation; *Murchison Medal* to Prof. H. H. Swinnerton, professor of geology in University College, Nottingham, for his stimulating contributions to the philosophy of palæontology; *Lyell Medal* to Mr. W. S. Bisat, for his studies in the stratigraphical palæontology of Carboniferous rocks; *Wollaston Fund* to Dr. E. S. Hills, for his contributions to Australian palæontology and geology; *Murchison Fund* to Dr. K. C. Dunham, for his investigations into the mineral deposits of the North of England; a moiety of the *Lyell Fund* to Dr. S. R. Nockolds, for his mineralogical and petrological work and his contributions to the study of assimilation processes; a second moiety of the *Lyell Fund* to Dr. J. Shirley, for his researches in palæozoic palæontology and stratigraphy.

## Institute of Metals: Platinum Medallist

THE Platinum Medal of the Institute of Metals for 1942 has been awarded to Mr. W. Murray Morrison, vice-chairman and managing director of the British Aluminium Co., in recognition of his outstanding services to the non-ferrous metals industries. Mr. Morrison is an original member and a fellow of the Institute of Metals, on the Council of which he served for sixteen years—in the last two as vice-president. He may be described as the father of the aluminium industry in Great Britain, having been associated with the British Aluminium Co. since its inception in 1894. He is also the pioneer of the developments of Highland water-power upon which depend the electro-metallurgical operations for the production of aluminium at three great Scottish factories.

## Institution of Mining and Metallurgy: New President

MR. J. ALLEN HOWE has been elected president of the Institution of Mining and Metallurgy for the year 1942–43. Mr. Allen Howe was educated privately and at the Royal College of Science, and holds the London B.Sc. degree. For a year he was demonstrator in geology at the Royal College of Science and Royal School of Mines, and in 1901 was appointed to H.M. Geological Survey, where he served for thirty years on the field staff and as curator of the Museum of Practical Geology, and from 1922 onwards as assistant director. During his service he took an active part in stimulating the economic side of the Survey's work, and he is the author of several works mainly dealing with building stone, broken stone, and refractory materials. On these and other subjects he has made numerous contributions, including many articles on topographical geology and stratigraphy in the Encyclopædia Britannica (thirteenth edition). He was a member of the International Conferences on Testing Materials, and was for a number of years adviser on stone to H.M. Office of Works and since 1918 to the Imperial War Graves Commission. He was a member of the Committee on Coal Conservation and the Imperial Economic Committee. Since 1931 Mr. Allen Howe has practised as a consultant in economic geology.

## *Chronica Botanica*

THIS international plant science news magazine, formerly published in Holland, continues to appear now from Waltham, Mass., U.S.A. Vol. 6, Nos. 17–18 appeared in November 1941 and is an exceedingly interesting number. Under the heading "Nomina ad Infinitum" Dr. F. C. Bawden asks for a more vigorous effort to rationalize procedure in the naming of virus diseases of plants, and then in the "Plant Science Forum" a number of subjects of general botanical interest are raised by well-qualified contributors. Very general interest will be aroused by a brief note from Dr. W. C. Darrah on the fossil embryos in Iowa coal balls; in particular, in the record of the discovery of the embryo and young seedling of a Lepidocarpon. There then follows a series of brief "Progress Reports" on plant science in Latin America, for example, on forestry in Mexico (Meyer), natural resources of Costa Rica (Skutch), etc.

International activities naturally do not bulk largely in the present day, but there is a note on the International Forestry Centre, which, established in May 1939 as a division of the International Institute of Agriculture, held its third meeting in March 1940 in Berne. The "Chronicle" of events has a very full statement of Kew activities in view of the centenary of the Royal Botanic Gardens in 1941: there is an interesting account also of the All-Union Agricultural Fair held in Moscow during 1939 and 1940 and again re-opened in the early summer of 1941. Details of the activities and vicissitudes of various botanical departments under present disturbed conditions make interesting reading to botanists, and similarly the many changes in personnel chronicled will often bring news of colleagues to readers. Very naturally the editors have contemplated closing this venture with the completion of vol. 6, and the extension of the War to the Pacific will possibly force them to reconsider their present decision to proceed at least with the issue of Vol. 7 in the form of twelve numbers to be issued once every

three months. If publication can be continued, however, this chronicle is probably more valuable to the botanical world under present conditions than even in normal times.

## Rapid Glass-house Repair

THE problem of repairing small holes in glass-houses both rapidly and economically has confronted many growers since the outbreak of war. After a thorough investigation of the matter, the Cheshunt Experimental and Research Station recommends the use of Bostik B. glazing compound, manufactured by the B. B. Chemical Co., Ltd., Ulverscroft Works, Leicester. The glass must be clean and perfectly dry. An extending nozzle is fitted to the Bostik tube, by means of which a thick flat continuous bead of the compound is delivered. This is allowed to dry for five or six minutes. The piece of glass which is to serve as a patch is then pressed lightly down on to the bead and a further film of Bostik applied around the outer edge of the patch to complete the seal. Glass substitutes can be used for patching instead of glass, and cracks can be satisfactorily sealed by a bead of the compound. All particulars are given in War-Time Notes No. 1, issued with the annual report of the Cheshunt Research Station for 1940.

## Health of Eire

ACCORDING to the report of the Department of Local Government of Eire for 1939–40, 1939, as in all parts of the world from which statistics are available, was a record year in Eire owing to the low prevalence and fatality of acute infectious diseases. There were only 2,779 notifications of scarlet fever with 43 deaths in 1939, both figures being much the lowest on record. There were 2,097 cases of diphtheria with 245 deaths which accounted for nearly two thirds of all deaths from endemic infections. The fatality rate of diphtheria, as in all parts of the world, unlike that of measles, whooping-cough, and scarlet fever, showed no tendency to fall. There was an apparent increase in the mortality from tuberculosis, but this was probably accounted for by an improvement in notification.

## Vital Statistics of Switzerland

RECENT statistics show that the decline in the birth-rate in Switzerland still continues. In 1939 it exceeded the death-rate by only 3·4 per thousand inhabitants as compared with 3·6 in 1938, 4·2 in 1936, 5·6 in 1930, 6·5 in 1920, 9·9 in 1910 and 11·5 in 1903. The death-rate reached its lowest record in 1934 and in 1937 with 11·3, but rose to 11·6 in 1938 and 11·8 in 1939. Since 1871, with few exceptions, the marriage-rate has fluctuated between 6·8 and 7·9, and the marriage age of single men has risen from 28·5 to 28·9, and of single women from 26·1 to 26·7.

## Mechanism of the Sun

THE presidential address to the British Astronomical Association was delivered on October 29 by F. J. Sellers, and dealt with the sun. Mr. Sellers is director of the Section of the Association dealing with the sun, and has done a considerable amount of research along certain lines. He has designed a very useful form of spectroscope and also a form of vibrating slit mechanism for the spectro-helioscope, and is a keen observer of solar phenomena. His address covered a very extensive field; here it is sufficient to say that the most up-to-date information on nuclear reactions in the interior of the sun, sunspots, the corona, chromospheric eruptions, etc., was discussed. The address is printed in full in the *Journal of the British Astronomical Association* (52, 1; 1941).

## The Night Sky in February

THE moon is full on February 1d. 9h. 12m. and new on February 15d. 10h. 2m. U.T. Lunar conjunctions with the planets occur on the following dates: Venus on February 14d. 0h., Venus 5° N.; Mars on February 22d. 1h., Mars 6° N.; Saturn on February 22d. 3h., Saturn 3° N.; Jupiter on February 23d. 19h., Jupiter 5° N. Mercury is an evening star until February 8, then a morning star. Venus is a morning star, and Mars, Jupiter and Saturn are evening stars. On February 24d. 2h. Mars is in conjunction with Saturn, Mars being 3·5° N. Mars, Jupiter and Saturn are still well placed for observation during the month. The planet Uranus, seen as a 6th magnitude star, is in the western part of Taurus and about 5° south of the Pleiades. In the latitude of London the day lengthens by about 1¾ hours during the month.

## Announcements

DR. SELIG HECHT, professor of biophysics at Columbia University, has been awarded the Frederic Ives Medal of the Optical Society of America for "distinguished work in the field of optics".

THE Pan-American League for the Control of Cancer will meet this year at Buenos Aires under the presidency of Prof. H. Angel Roffo.

THE International Commission on Continental and Oceanic Structure of the International Union of Geodesy and Geophysics (chairman, Dr. R. M. Field) has found means to continue in operation the Scoresbysund seismological station, originally run in connexion with Danish stations. Funds were granted by the American Philosophical Society of Philadelphia, which will supply paper and other photographic materials for another year of operation. The supplies have been shipped.

THE Rugby Branch of the Association of Scientific Workers is conducting a series of lectures and meetings, held on Thursdays, on the general theme, "The Coming Post-War World". Among the speakers are Prof. V. H. Mottram on the social implications of dietetics, Capt. J. Langdon Davies on scientific invention at the service of the community, and Prof. A. St. G. Huggett on the social basis of physical and psychological health. Particulars can be obtained from the honorary secretary, J. B. Laurie, Upper Rainsbrook, Ashlawn Road, Rugby.

THE Clough Memorial Research Fund was instituted in 1935 for the purpose of encouraging geological research in Scotland and the North of England. The North of England is defined as comprising the counties of Northumberland, Cumberland, Durham, Westmorland and Yorkshire. Under the terms of administration of the fund a sum of approximately £30 is available annually. Applications for grants are invited for the period April 1, 1942—March 31, 1943, and should be made to the Secretary, Clough Research Fund Committee, Edinburgh Geological Society, Synod Hall, Castle Terrace, Edinburgh, not later than March 1.

# LETTERS TO THE EDITORS

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

## Uplift in Dams

IN the design of masonry or concrete dams, the uplift due to the penetration of water into the structure is a factor which up to the present has not been completely investigated. Previous experiments intended to solve the problem gave rise to much controversy as to the interpretation of the results[1].

In the following experiments, which were made for the Projects Department of the Ministry of Public Works, Egypt, results have been obtained which are independent of theories about the internal structure of the material.

The apparatus consists of a test chamber in which a cylindrical test-piece of concrete of length 60 cm. and diameter 15 cm. is placed in such a manner that one of its extremities projects beyond the container. The test chamber is connected to a water supply the pressure of which can be raised by an accumulator, and this water pressure is applied to the middle part of the outer surface of the test-piece. At the same time the test-piece can be subjected to an axial compression or tension by means of a system of levers and weights. This force varied from 5 tons compression to 2 tons tension. The test-piece has a hole of 4 cm. diameter along its axis to allow air to escape from the pores, but more important, to make certain that the external water pressure is acting right through the specimen when failure occurs. In making an experiment, the longitudinal force $N$ is first applied, and then the pressure of the external water is raised to a pressure $P$ and maintained constant while water percolates through the specimen and produces a pressure $Q$ in the axial cavity. The external pressure is raised by slow steps, depending on the rate of rise of $Q$, until fracture takes place. The whole experiment takes from three to five days to complete.

To understand the principle of the experiment we imagine the simple case where a solid cylinder, the area of cross-sections of which is $S$, is compressed by a longitudinal force $N$ and finally broken after a long time by the external water penetrating the material under pressure $P$. The pressure $P$, owing to the porosity of the substance, acts over a fraction $f$ of the cross-section : let the resistance of the material just before breaking takes place be $z$. Then we have

$$PfS = z + N,$$

where we do not know either $f$ or $z$.

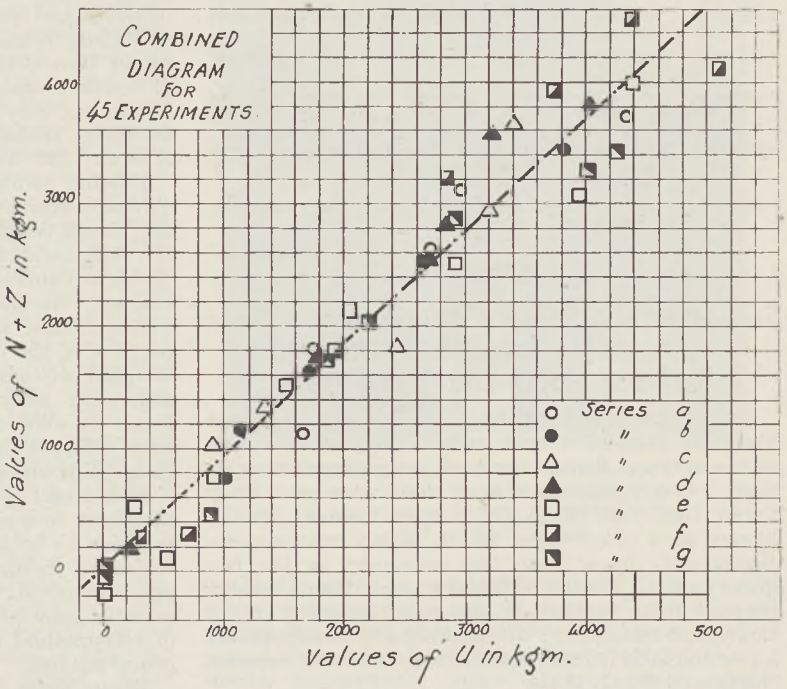
By making a number of experiments with different values of $N$, we obtain a series of equations from which we can determine $f$ and $z$.

In the experiments, the pressure $p$ in the interior of the test-piece varies from $P$ outside to $Q$ inside, the two being not necessarily equal. $PS$ is therefore replaced by $\int pdS = U$, the value of which is :

$$U = QS + (P - Q)S\left[\frac{D^2}{D^2 - d^2} - \frac{1}{2 \log D/d}\right].$$

While this formula was developed from the elementary theory of laminar flow, it was also verified empirically and found fairly accurate both in regard to the experiments under review and other experimental investigations[2].

For determining the coefficient $f$, some six or ten test-pieces are made of the same material and these are broken each with a different external load $N$. The values of $U$ are then calculated and plotted against $N$. Allowing for the unavoidable variation of the test-pieces, the relation between $U$ and $N$ is found to be linear. The coefficient $f$ is therefore given by the slope of the line expressing this relation. Contrary to what might have been expected, $f$ was not very much affected by the materials or methods used in making the specimen, and only varied from 0·85 to 0·98, with a mean value of 0·92. In consequence of this, it has been possible to plot the results of the forty-five tests made up to the moment on a single diagram.




The materials used and the individual coefficients found were :

| Series | Proportion of cement to sand and to coarse aggregate (volumes of dry materials) | Type of sand | Type of coarse aggregate | Water-cement ratio | $f$ |
|---|---|---|---|---|---|
| *a* | 1·0—1·6—1·1 | Average | Crushed | 0·40 | 0·88 |
| *b* | 1·0—2·7—3·3 | ,, | Granite | 0·93 | 0·92 |
| *c* | 1·0—1·1—2·2 | ,, | ,, | 0·50 | 0·95 |
| *d* | 1·0—2·3—4·2 | ,, | ,, | 0·72 | 0·99 |
| *e* | 1·0—1·7—4·6 | Coarse | ,, | 0·58 | 0·87 |
| *f* | 1·0—1·1—2·2 | ,, | Gravel | 0·40 | 0·96 |
| *g* | 1·0—2·8—0·0 | ,, | — | 0·44 | 0·85 |

The probable deviation of a point from the mean line is about ± 200 kgm., while the probable error of $f$ is only ± 0·02.

The observations were examined statistically for systematic effects due to varying ages of the specimens, or to changes of the tensile resistance $Z$ due to compressive ring stresses at right angles to the main axis, or to variation of the superimposed load $N$. No effects of this nature were found.

The porosity of some specimens was determined by weighing and drying, and was always less than 20 per cent. The fraction of the area of cross-section over which the internal pressure acts can therefore have nothing to do with ordinary porosity, and the results of the experiments tend to support Prof. Terzaghi's views. They may lead to changes in the methods of allowing for uplift in the design of dams.

Further work is going on, and it is intended later to publish a full account of the work in an Egyptian Government publication.

SERGE LELIAVSKY.

Projects Department,
Ministry of Public Works,
Cairo.

[1] *Mitt. a. d. mech.-techn. Lab. d. k. Techn. Hochsch. München*, **27**, 1 (1900).

[2] Rudeloff and Panzerbieter, "Versuche über den Porendruck des Wassers im Mauerwerk" (Berlin, 1912).

[3] Fillunger, "Versuche über die Zugfestigkeit bei allseitigem Wasserdruck", *Oesterr. Woch. f. d. öff. Baudienst*, **29** (1915).

[4] Hoffman, "Permeazioni d'aqua e loro effeti nei muri di ritenuta" (Milan, 1928).

[5] Terzaghi, "Die wirksame Flächenporosität des Betons", *Z. öst. I. und A. Vereines*, Heft 3/4, p. 1, Heft 5/6, p. 30, Heft 7/8, p. 45 (1934).

[6] Fillunger, "Nochmals der Auftrieb in Talsperren" and "Die wirksame Flächenporosität Prof. Terzaghi's", *Z. öst. I. und. A. Vereines*, 5/6, 28, and 7/8, 44 (1934).

[7] Terzaghi, "Simple Tests Determine Hydrostatic Uplift", *Eng. News-Record*, p. 872 (June 18, 1936).

## Surnames and Blood Groups, with a Note on a Probable Remarkable Difference between North and South Wales

Two years ago[1] Prof. R. A. Fisher and Dr. Janet Vaughan suggested that recent population movements in Great Britain can lead to significant association between surnames and blood groups. They found that out of 11,377 donors resident in the Slough area 591 bearing Welsh family names were significantly lower than the remainder in the frequency of $A$. Counts of blood groups donors now in progress have yielded striking proof of the value of this simple technique; and incidentally have revealed a startling and (to me) unexpected difference between North and South Wales.

Taylor, Race and Fisher[2] have given figures which illustrate the great variability in the frequency of $A$ in the British Isles: Southern England, $O = 45$ per cent, $A = 43$ per cent; Northern England, $O = 48$, $A = 40$; Scotland, $O = 52$, $A = 34$. Haldane[3] gives the following figures for an Irish sample: $O = 56$, $A = 30$. These figures will serve as a standard of comparison for those given in the present communication.

A sample of 2,550 Welsh donors, drawn from Caernarvonshire, Denbighshire and Flintshire, gives: $O = 48$ per cent, $A = 40$ per cent. When, however, the sample is divided into 1,132 donors with Welsh family names and 1,418 donors with non-Welsh family names, the Welsh donors give $O = 51$, $A = 36$: the non-Welsh donors give $O = 45$, $A = 43$. The difference is highly significant. (The high proportion of non-Welsh names in the sample is largely due to the North Welsh coastal area being strongly represented.) Here, then, the family name technique has unmasked the diluting effect of recent migration and has revealed an important difference in blood groups between two partially isolated populations inhabiting the same area.

Another positive result was found when donors with Highland Scottish and Irish names living in the Bristol area were compared with the remainder. 40,740 donors in this area have given $O = 44$, $A = 44$. 778 donors with characteristically Highland or Irish names have given $O = 49$, $A = 38$, again a highly significant difference.

During the course of this work it became apparent that North and South Wales were strangely different. The first piece of evidence was that 3,242 donors with Welsh names drawn from the Bristol sample were as high in $A$ as the remainder. Yet much of this immigration must be very recent, for the proportion of men was considerably higher among the Welsh donors. As Welsh names in Bristol must be overwhelmingly of South Welsh origin, the North Welsh material was re-examined, the Welsh names being classified according to their relative frequencies in North and South. I relied on Guppy's "The Homes of Family Names"[4] in making the selection. It was found that donors with names more characteristic of South Wales were significantly higher in $A$. Prof. Fisher has very kindly provided some figures relating to South Wales. 1,765 Cardiff donors give $O = 45$, $A = 43$; 537 Swansea donors give $O = 45$, $A = 40$.

Further work is in progress, but even on the evidence now available it seems probable that while the North Welsh are, as regards blood groups, kin to the Highland Scots and the Irish, the Southern Welsh are almost indistinguishable from the Southern English. Surnames came into common use in Wales during Tudor times, so it appears likely that the peoples of the North and South who at that time adopted the same family names were already very different; after all, perhaps, not such a surprising result in view of the different influences known to have affected the two parts of the country and the great difficulties of communication between them.

Fisher and Vaughan[1] have undoubtedly directed attention to a simple and valuable technique, and it is much to be hoped that blood group investigators will avail themselves of it in connexion with appropriate material. The additional clarification thus made possible may often be considerable. The usefulness of the method is not, of course, confined to blood group studies.

When these investigations are complete it is intended to report them fully in the *Annals of Eugenics*. I will then take the opportunity of expressing my great indebtedness to all those who have so kindly provided the facilities which have made the work possible.

J. A. FRASER ROBERTS.

Burden Mental Research Department,
Stoke Park Colony,
Bristol.
Jan. 2.

[1] NATURE, **144**, 1047 (1939).
[2] *Brit. Med. J.*, **1**, 315 (1941).
[3] *Human Biology*, **12**, 457 (1940).
[4] London, Harrison and Son (1890).

## Vernalization of Mustard

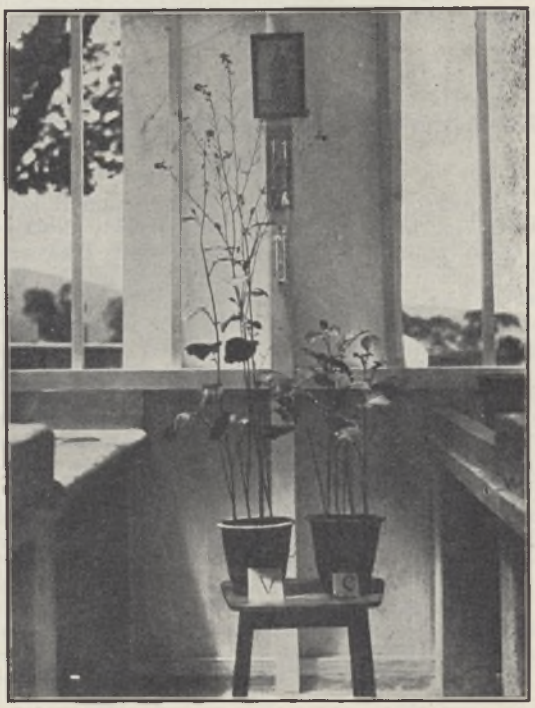
In our preliminary report[1] on vernalization of mustard (*Brassica juncea*, Hooker Type 27) it was shown that even seeds previously soaked which remain unsplit during the period of chilling are vernalized. Though the degree of vernalization induced by the same dose of chilling is greater in seeds which sprout during the period, only unsplit chilled seeds offer practical agricultural possibilities, since the latter can be dried without impairment of subsequent germinating capacity. Four other strains of Indian mustard—Types *C*.9, *C*.11, Raya *O.B*.1, and yellow sarson—have all since been found to respond to vernalization. For the same dose of chilling, the shortening of the vegetative period (from sowing to opening of the first flower) of plants from unsplit chilled seeds have been found to vary according to the strain.

Most of our vernalization experiments with mustard have been carried out with Type 27, in which maximum vernalization is induced in unsplit seeds when chilled for six weeks. Further prolongation of chilling up to 365 days does not induce any higher degree of vernalization, nor any devernalization.

Lojkin[2] found that vernalized seeds of winter wheat when air-dried at 1° C. and 15° C. were partially or completely devernalized, and Gregory and Purvis[3] observed complete devernalization when fully vernalized seeds of winter rye were dried for twenty weeks. Drying vernalized unsplit mustard seeds, however, is surprisingly without effect. For it has been found from a long series of sowings, spread over a period of two years, of the same batch of dried vernalized unsplit seeds, that the vegetative periods of *V*-plants sown on similar dates in two successive years (subjected to more or less the same after-sowing temperature ranges and photo-periods) remained strikingly constant. Thus, in the first sowing (April 24, 1939) when the *V*-seeds had been dried for twenty-one days only, the observed vegetative period was 31·9 ± 0·54 days (mean of eight plants), and in the ninth sowing, April 24, 1940, when the period of drying was 387 days, the vegetative period observed was 30·5 ± 0·41 days (mean of 15 plants). Similarly, in the eighth sowing, March 20, 1940, and the twentieth sowing, March 28, 1941, the respective periods of drying were 352 and 725 days, and the vegetative periods of *V*-plants were 37·5 ± 1·48 days (mean of 4 plants) and 34·9 ± 0·57 days (mean of eight plants). These results indicate that drying of vernalized unsplit seeds of mustard for a period of 725 days did not induce any devernalization. In the case of vernalized intact fruits of winter rye also, which Gregory and Purvis[3] obtained by chilling the embryo in the ear during seed formation, drying did not induce devernalization. Thus it would appear that when the growth of the embryo is confined within the elastic limit of the seed-coat, chilled seeds can be dried without resultant devernalization.

Results of seasonal sowing (October 1939) of fully vernalized unsplit seeds of mustard along with the controls in replicated field plots show that under the climatic conditions of Almora a significant earliness in flowering of 25·4 days (31·3 per cent) in Type 27, 20·3 days (23·8 per cent) in *C*.11, and 29·57 days (31·3 per cent) in *C*.9 can be obtained by the use of vernalized unsplit seeds.

The observed vegetative periods of *C*- and *V*-plants (Type 27) grown throughout the year under different seasonal temperature ranges but under similar effective photo-periods indicate that: (1) Mustard Type 27 has no obligatory low-temperature requirement for the *first phase* of development, for plants from untreated control seeds flowered when the minimum night temperature was 20° C. or higher. On the other hand, under all different after-sowing temperature ranges studied (max. day temperature 44°–10° C. and minimum night temperature 22°–1° C.) and of photo-periods (10–16 hr.), plants from fully vernalized unsplit seeds flowered significantly earlier; (ii) Mustard Type 27 flowers under photo-period of 10 hr. as well as 16 hr.; but under all temperature ranges studied both *C*- and *V*-plants flower significantly earlier with increase of photo-period from 10 hr. to 13 hr. for the initial three weeks; (iii) within



MUSTARD TYPE 27. PLANTS IN POT *V* ARE FROM VERNALIZED UNSPLIT SEEDS CHILLED SIX WEEKS, DRIED SIX DAYS; IN POT *C* ARE PLANTS FROM CONTROL, UNTREATED SEEDS. BOTH SOWN ON JULY 11, 1938.

limits, the effect of low temperature during the *first phase* of development and of increased photo-period during the *second phase* in shortening the vegetative period of mustard is of a *quantitative* nature. Under similar temperature ranges *V*-plants under photo-period of 10 hr. and *C*-plants under photo-period of 13 hr. or more have been found to have similar vegetative periods. The original concepts of Lysenko's theory of phasic development of annual seed crops[4] therefore do not seem to apply to Mustard Type 27, either with regard to the obligatory nature of changes produced by low temperature during the *first phase* or the strict dependence of each phase on the completion of the preceding one.

The observed vegetative periods of plants from the progeny of seeds vernalized for three successive generations of Mustard Type 27 do not indicate any transmission of the effect of vernalization to the offspring. But low temperature during the period of

seed ripening has been found to produce partially vernalized seeds.

A detailed report of this work is being published in a forthcoming number of the *Indian Journal of Agricultural Science*. Expenses of the investigation have been met by grants from the Elmgrant Trust of Dartington, Totnes, and the Imperial Council of Agricultural Research, New Delhi.

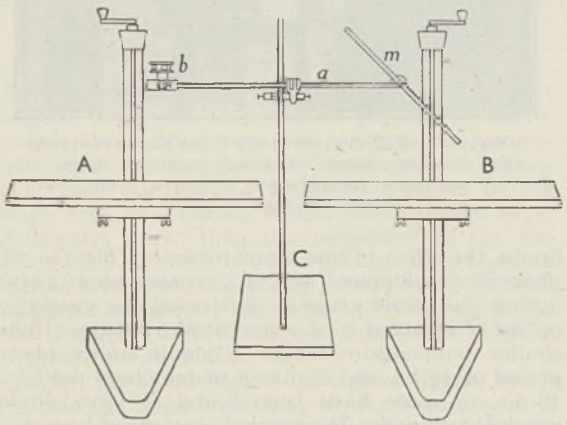
B. SEN.
S. C. CHAKRAVARTI.

Vivekananda Laboratory,
Almora, India.
Nov. 3.

[1] Sen, B., and Chakravarti, S. C., *Ind. J. Agric. Sci.*, 8, 245 (1938).
[2] Lojkin, M., *Contr. Boyce Thompson Inst.*, 8, 237 (1936).
[3] Gregory, F. G., and Purvis, O. N., *Ann. Bot.*, N.S., 2, 237 (1938).
[4] Bulletin 17, Imperial Bureau of Plant Genetics (1935).

## Use of the Camera Lucida for Transcribing Diagrams

INTERESTING modifications of the camera lucida for making larger drawings were recently described in these columns[1]. A novel use to which I have put this apparatus may also assist biologists in their work. Teachers and research workers in biology who regularly abstract information from the original literature must have felt the need for obtaining accurate copies of diagrams and figures which accompany the text of publications. Various methods of transcription are known; but apart from tracings, which leave much to be desired, they call for apparatus which is rarely available. The following method of using an ordinary camera lucida of the Abbe type for transcribing diagrams has the advantage of permitting enlargement or reduction of the original.




Two small drawing boards are provided on their lower surfaces each with a U-shaped support of $\frac{3}{8}$ in. iron rod having two projecting lugs which will fit into the clamps of a pillar stand such as is used in physiological experiments. The stands to which the boards have been clamped are placed to the left and the right (*A* and *B* in accompanying figure) of an ordinary retort stand (*C*) the clamp of which grips the arm (*a*) of the camera lucida so that the prism and light filters (*b*) of the apparatus overhang the left board (*A*) while the mirror (*m*) overhangs the right board (*B*). The distance apart of the pillar stands is determined by the length of the arm (*a*), the vertical level of which is in turn determined by the work in hand. Each board can be raised or lowered separately by rackwork through a vertical distance of approximately eighteen inches.

The figure which is to be copied is placed upon board *A* and covered with a sheet of plate-glass, and the paper on which the copy is to be made is pinned in position upon board *B*. The drawing is made exactly as if the camera lucida were being used for microscopic work, that is, the object is viewed through the perforated prism at *b* (as is the image of a microscopic object) and is seen in relation to the image of the paper which is superimposed upon it as a result of light reflexion from the mirror and the prism.

When the boards *A* and *B* are set at the same horizontal level the copy will be enlarged (my apparatus gives a ratio of approximately 4/3), but by setting the boards at different levels various amounts of reduction or enlargement can be achieved. The lowering of board *A* and the raising of board *B* favour reduction and vice versa. With ordinary equipment I obtained at the two extremes a reduction by one half and an enlargement of five diameters respectively. The methods advocated by Harding for enlarging drawings may be used to increase this range.

The ordinary light screens with which the camera lucida is provided also serve when the apparatus is used for the transcription of diagrams, but modification of the lighting arrangements to suit individual needs is advantageous. Manipulation of bench lamps will remove any lighting difficulties.

The alternate focusing of the eye on the diagram and the copy may involve strain, especially when the apparatus is being used for reduction or enlargement. This can be avoided by placing a biconvex spectacle lens above the prism of the camera lucida. When preparing enlarged or reduced copies of the original diagram, I use lenses of 13 in., 18 in. and 20 in. focal length, with the alleviation of eye strain and with greater ease of working.

Some difficulty might be experienced when the figures which are to be copied occur in large volumes or manuscripts. This can be overcome by the use of a sliding mirror (*m*) on an appropriately lengthened arm (*a*).

This arrangement of ordinary laboratory equipment may be used for preparing graphical records of published diagrams in original papers and for accurate diagrammatization of complex figures for teaching purposes. I have used it for transcribing unequal original diagrams of related Trematoda to the same size in the copy[2]. This means of cancelling out absolute size differences revealed *relative* differences which are of some taxonomic importance, but which were obscure in the originals.

BEN DAWES.

Department of Zoology,
King's College, London,
at The University,
Bristol.
Jan. 5.

[1] Harding, NATURE, 148, 754 (1941).
[2] Dawes, *Parasitology*, 1942 (in the press).

# RESEARCH ITEMS

## The European Earwig in America

IN Technical Bulletin 766 (1941) issued by the U.S. Department of Agriculture a very full account is given of this insect and of methods for its control. The authors, S. E. Crumb, P. M. Eide and A. E. Bonn, describe in the first place its distribution, where it occurs on both the eastern and western sides of North America. It appears to have been first noticed in Rhode Island, in the west, in 1911 and, in the east, at Seattle in 1907. It has also become established in British Columbia, where it was first noted in 1919. The survival and abundance of the insect are dependent mainly on the amount of desiccation to which it is subjected, it being best adapted to cool latitudes. It is omnivorous, but prefers the lower plants (algæ, lichens, etc.) to most of the higher types of vegetation. The eggs are deposited in cells in the soil in January and February and the adults begin to appear in July. A proportion of the females re-enter the soil in about May and deposit a second batch of eggs. The female watches over the eggs and first instar nymphs and will fight savagely in their protection. The earwig rarely flies, but the authors state that they have noticed as many as twenty flights in one day. Although so pronouncedly nocturnal in many of its habits, it seems to fly mostly in bright warm sunshine. It is considered that the best method of repressing this insect is by means of poisoned baits. The one found most successful on a large scale consists of a mixture of wheat bran, twelve parts by weight and one part each of sodium fluosilicate, and fish oil.

## Beetles of the Family Lathridiidæ

DR. H. E. HINTON of the Department of Entomology, British Museum (Nat. Hist.), has contributed an article (*Bull. Ent. Res.*, November, pp. 191–247) on Lathridiid beetles of economic importance. Altogether about thirty species of this family have been recorded among stored food products or have occurred in warehouses, granaries or mills. Among these, ten species have not hitherto been recorded from Britain. Under each species are given summaries of its distribution, life-history and the literature relating thereto. Also, for the first time, complete life-histories of five species have been worked out, and the larval and pupal stages are carefully figured. The family as a whole comprises about 520 species, all small (1–3 mm. long) and they, together with their larvæ, are found in mouldy plant and animal substances, in mycetozoa and fungi, in vegetable detritus, under bark and stones and sometimes in ant and termite nests. Both stages apparently only feed on mycetozoa and fungi, particularly moulds. It appears that none of the species dealt with is responsible for any direct injury to food, since they are exclusively fungus feeders. When present in considerable numbers, they may cause a certain amount of damage by fouling food substances with their fæces. Since they are able to transmit moulds to uncontaminated foods, they may in this way entail losses. Control measures comprise drying, heating, or fumigation. Any measures that will eliminate fungi will also be effective in getting rid of Lathridiid beetles.

## Somatoplastic Sterility

R. A. Brink and D. C. Cooper (*Genetics*, 26, 487–505; 1941) have studied the development of seeds in the cross *Nicotiana rustica* × *N. tabacum*, which rarely produces viable seeds, and in *N. rustica* × *N. glutinosa*, in which no viable seed is produced. They find that endosperm growth is retarded, hyperplasia of the nucellus occurs, and the cells of the integument between the apex of the vascular bundle and the chalazal pocket do not differentiate into conducting tissue. Where the endosperm and the embryo do grow in the first cross, it is found that they grow at the expense of the neighbouring integumental cells, which are thereby depleted of their contents. The authors consider that this somatoplastic sterility is of widespread occurrence in economic plants such as apples, pears, or seedless fruits, and is of great importance in regard to such phenomena as June-drop, poor cropping and varietal differences in fertility.

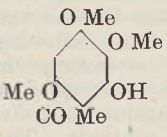
## Chromosome Homologies in the Genus Drosophila

THE result of the intensive experimental work of the last twenty years is bearing fruit in providing an insight into the genetical composition of the chromosomes of the various species of Drosophila. In an important paper, A. H. Sturtevant and F. Novitski (*Genetics*, 26, 506–517; 1941) have summarized the facts from more than thirteen species of Drosophila. Taking the arm from the centromere to the end of the chromosome as the unit or element, it is shown that the six arms of the chromosomes of *D. melanogaster* retain their genetical identity in the remaining species. Within each element the sequence of the genes is dissimilar between the species, and it is shown that the different sequences of the genes in *D. melanogaster* and *D. pseudo-obscura* are not more alike than would result from chance. Few or no translocations have become established in these two sub-genera. A change in chromosome number would appear to occur by a special type of translocation within the heterochromatin area near the centromeres. This would more likely decrease chromosome number; hence *D. virilis*, in which the six elements are separate, is taken as the most primitive. The higher Diptera have six chromosomes. Whether these are identical with the Drosophila elements is unknown, but the integrity of the elements must break down in the more distantly related Diptera species.

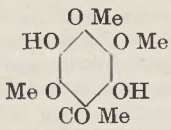
## Derivatives of Pentahydroxybenzene

THERE has been an increasing interest in naturally occurring derivatives of pentahydroxybenzene, and these (calycopterin or thapsin, nobiletin, spinulosin, erianthin and pedicin and closely related compounds) are mentioned by W. Baker (*J. Chem. Soc.*, 662; 1941), who reviews recorded syntheses of pentahydroxybenzene derivatives and describes some very simple syntheses starting from pyrogallol, as a result of which, for the first time, some of these substances may now be very readily prepared. The pyrogallol was converted into 1 : 2 : 3 : 5-tetramethoxybenzene from which pentamethoxybenzene can be prepared by way of two intermediates. The synthetic methods make use in the final stage of the oxidation of *o*-hydroxytrimethoxyacetophenones by alkaline hydrogen peroxide to give dihydroxytrimethoxybenzenes. The catechol derivative is oxidized by aqueous ferric chloride to the quinone, various derivatives of which are described. The compound is oxidized by alkaline potassium persulphate to the pentahydroxyacetophenone derivative (II), from which the naturally occurring chalkone pedicellin (III) is synthesized. Pentamethoxybenzene, by the action of acetyl and

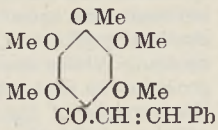
aluminium chlorides in ether, gives hydroxypentamethoxy acetophenone, from which (see NATURE, Jan. 10, p. 52) hexamethoxybenzene can readily be obtained.




(I)

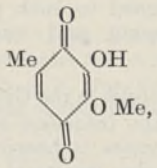



(II)




(III)

A synthesis of the mould metabolic product fumigatin, 3-hydroxy-4-methoxy-2 : 5-toluquinone,




a derivative of tetrahydroxybenzene, is also described by W. Baker and H. Raistrick (*J. Chem. Soc.*, 670; 1941).

### Preparation of Deuterium Compounds

SOME experiments on the preparation of tetradeuteroethylene $D_2C : CD_2$ are described by C. L. Wilson and A. W. Wylie (*J. Chem. Soc.*, 598; 1941). This substance has been prepared before, for example, by introducing deuterium into the ethylene molecule by exchange in presence of a nickel or platinum catalyst and by the combination of deuteroacetylene and deuterium bromide under the influence of ultra-violet light, followed by the removal of bromine from the resulting dibromoethanes by zinc. The present authors find that a mixture of isomeric dibromotetradeuteroethanes containing about 10 per cent of ethylidene dibromide is formed by passing deuterium bromide (an apparatus for preparing which from bromine and electrolytic deuterium is described) and dideuteroacetylene over a prepared charcoal catalyst at 180°. The best sample contained 99·7 atom per cent of deuterium. The isotopic analysis was made by burning a mixture of the sample with highly purified ordinary ethylene dibromide by passing in a stream of dry air over red-hot copper oxide, purifying the combustion water, determining its density, and calculating the deuterium content by a formula. The reaction with zinc of the mixed deuterobromides in solution in purified dioxane to which one drop of deuterium oxide had been added was the method used for the preparation of tetradeuteroethylene, by reaction of which with bromine pure tetradeuteroethylene dibromide was obtained.

### Comet Positions by Cross-bar Micrometer

W. T. HAY has described his home-made micrometer specially used for the determination of comet positions (*J. Brit. Astro. Assoc.*, 52, 1; 1941). The cross-bar micrometer consists of two metal wires (in the present case 10-amp. tinned copper fuse wire) set at an angle of 90° to one another and crossing in the middle of the field. A third wire bisects two of the right angles thus formed, and it is used for setting the micrometer in its correct position; this is attained by setting the third wire parallel to the celestial equator, so that a star will move along it when the telescope is moved in right ascension. When a comet and a star have been located in the same field, the driving clock of the telescope is stopped, allowing the two objects, which should be north and south of the field, to drift across the field of view. The difference between the mean of the times when the star crosses the wires, say, north of the field, and when the comet crosses the other two wires on the south of the field, gives the difference in right ascension in mean time seconds, which is then reduced to sidereal seconds. Half the sum of the times required by each object to cross its wires, reduced to sidereal seconds, multiplied by 15 times the cosine of the declination, gives the difference of declination in seconds of arc. In a separate paper Hay gives the results of nine observations of Comet van Gent, and from these Davidson and Sumner computed an orbit (see NATURE, 148, 562; 1941) which is slightly hyperbolic.

### Leander McCormick Proper Motions

A. ALI has published (*Mon. Not. Roy. Astro. Soc.*, 101, 7; 1941) the result of the preliminary work done in connexion with the study of proper motions of the faint stars in the *Publications of the Leander McCormick Observatory*, 5, 11 (1937), on the basis of the two-streams theory. Three groups, which included about 2,100 stars, were selected sufficiently far apart from each other to give a fair idea of the preferential motions. As the form of the frequency curve was found to be very sensitive with regard to the position of the absolute origin in each region, three "absolute" origins were employed in each region, their respective frequency curves being obtained. A description is given of the method for determining the three absolute origins, and three figures show the frequency curves for Group 21 and Regions 276 and 295 included in it. The frequency curves, generally speaking, are distorted by considerable irregularities, and it is difficult to analyse them by Eddington's 'trial and error' method. Indeed, the absolute origin is indeterminate, indicating the presence of systematic or relatively large accidental errors, and it is suggested that a systematic error may exist in all the galactic regions in the McCormick memoir.

### Interstellar Lines in the Laboratory

THREE sharp interstellar lines at 4232·6, 3957·7 and 3745·3 A., which had not hitherto been identified, have been reproduced by A. E. Douglas and G. Herzberg (*Astrophys. J.*, 94, 381; 1941) in a discharge through helium containing a trace of benzene vapour. They are the $R(0)$ lines of three bands, with heads at 4225·3, 3954·0 and 3743·4 A. respectively, each of which consists of three singlet branches corresponding to a $^1\Pi - {}^1\Sigma$ transition. The laboratory and interstellar wave-lengths are in agreement to 0·03 A. The only lines of these bands which would be expected in interstellar space are those coming from the lowest rotational level of the lower state, which are just the ones observed. Since the molecule BH has a $^1\Pi - {}^1\Sigma$ system with a (0,0) band in this region, and since the rotational constant in the lower state of the new bands is close to that for CH, the isoelectronic $CH^+$ is suggested as the emitter. This suggestion is strengthened by the fact that the other neutral and singly ionized hydrides of the second period of the periodic system are all well known except for three, which in any case cannot have singlet bands. The presence of $CH^+$ in interstellar space, as well as the neutral molecule CH discovered some months ago, seems thus to be established.

# AN EXPERIMENT IN SOCIAL SCIENCE

THERE is a growing appreciation of the problem of the relation between management and labour : it is one which bristles with difficulties, in part because there is a lack of understanding on both sides and often, indeed, unwillingness to try to understand. As labour grows more and more independent, partly because of its political power, it becomes more necessary than ever to seek any and every means to promote such understanding, so that a factory can be run for the common weal, to give continuous remunerative employment to all connected with it, to give a fair return on the money invested in it, having regard to the risk, to set aside sufficient for depreciation and development so that the business may last for generations and not collapse exhausted in a few years like the wheat fields of the West after half a dozen crops.

If these prime essentials are agreed, then every worker, high or low, must actually earn, that is, produce goods of a value greater than his pay ; if he fail to do this, then he is a drag on the concern and must be removed or it will fail. The usual stupid remedy for bad times is to reduce wages ; a more scientific solution would be to increase the amount of work and cheapen the product, thereby making it more competitive and easier to sell. Unfortunately, the economics of bad and good times are more complex than the above simple basic principles, but none the less they are still largely applicable in most factories.

It is the task of management to see that every worker is able to earn more than his pay by adequate production, also that quality is maintained, research and development fostered, plant and machinery kept in order. Over and above this, good management has an even more important task based on the recognition that the workers are not herds but individuals with hopes and aspirations, people to lead rather than drive. In the old family concern the boss—"old Mr. Tom"—knew most of the work-people by their given names and something about their hobbies ; to-day this is much more difficult, especially when an overworked general manager has several thousands under him. Much can, however, be done, and it may be of interest to give an account of efforts made in a large factory employing both sexes some twenty-five years or more ago, largely before general interest was attracted to such questions.

The work is conveniently grouped under the headings of education, recreation, health ; we anticipated Hitler in devoting most of the efforts to the young people, remembering both that they are most impressionable and are continuously growing up.

*Education.* All young persons, as the Factory Act calls them, had to pass a certain standard before being taken on. The girls had to pass the top standard to qualify for the 'cleaner' work, for which there was always a long waiting list. The top standard was also required for the laboratory, to which a limited number were recruited each year after an interview by the chief chemist. The laboratory was regarded as the training ground for the staff. Everyone in it had to go to evening classes at the expense of the firm, at first in the home town and afterwards at the nearby city, to which travelling expenses were paid : some obtained external B.Sc. degrees in this way. (This was before the days of occasional day-time release which Dr. A. P. M. Fleming has since sponsored.)

At the end of the year the progress of each man was reviewed and a few 'square pegs' discharged. It was considered fairer to do this at the start than let them grow old in jobs for which they had little aptitude and probably less inclination. Such a system gives a larger number of recruits the chance of making good. Payment was by an age scale. The laboratory lads were encouraged in every way to take part and help in the social work and to develop any talent for organization or leadership. One got to know them well and to select those best fitted to be under-managers, alternatively research assistants. To-day some of them are managers in responsible positions.

On a smaller scale, the same progressive training was extended to the technical director's personal staff, which handled all works questions not pertaining to the actual processes. It was ripe for extension to the whole works, where any promising boy, generally discovered through the Scouts, was picked out and given a chance.

The advantage to the lads of this training is obvious : what the firm gained was a reservoir of men of all grades of ability available to fill gaps at home or abroad. We knew them and they knew our methods, a system which was infinitely more satisfactory than bringing in strangers.

*Recreation.* It is essential that the workers should manage their own affairs, but they need and welcome guidance in their organization. They do not want recreation arranged for them by a welfare staff. Our Girl Guides were highly successful, there was a waiting list to join them and a high standard of conduct was set ; here more than anywhere was there an opportunity of teaching the team spirit. The Boy Scouts were also popular, but the boy at this age very properly is more inclined to go his own way.

The company had provided a particularly fine recreation hall and canteen, including a theatre, which was the centre of a variety of activities all managed by the work-people and staff. The most interesting were the dances, sectional or large, which were self-supporting. These were visited by the technical director and certain members of the staff and their ladies—there was no formality or segregation. We were told our presence was desired and helped to make the affairs a success. I have no more pleasant recollection than the comparison of the dresses and general appearance of the girls at the beginning of these efforts and fifteen years later, and the young men had equally progressed. This social progress was in itself ample payment for much time devoted to this work—the girls made better marriages as one consequence of it. The credit was due in particular to the tact and general self-sacrifice of our lady manager, but it was personal also to a surprising extent, for on a change of management which withdrew the personal touch, the social functions languished and became less successful.

Interdepartmental games are a good method of fostering pride in the departments, and competitions for shields and cups, which are exhibited in the workshop all the year, do a lot of good in making workers feel they are part of a large family and not mere hands. The success of these, however, depends on a display of interest in them by the management ; they tend to die away if left to the players themselves.

We never found a means of really breaking down the barrier between works and office on the social side—a stupid distinction which in reality was non-existent—for the many offices in the works counted as works staff and played with us. Perhaps we did not try hard enough and left the office folk to find out what they were missing.

*Health.* The health of the worker should be a matter of concern to management. Quite apart from occupational diseases and epidemics, undue sickness in any one department is a sign that something is wrong and needs investigation. Departmental as well as general statistics should be reported. An undue amount of sickness among the girls led to the discovery that in order to get to work in time in the morning, many of them neglected to have a proper breakfast. A 40-minute-later start, that is, a 44- instead of a 48-hour week, was tried as an experiment, with an agreement on the part of the workers that they would try to maintain output and on ours that they would not lose pay. When things had settled down, it transpired that in the long run a slightly larger output was obtained and the sickness figure fell considerably. A watch on the sickness figure of small sections usually led to the discovery and rectification of the cause.

Many sections of the firm were working under conditions of limited floor space while new buildings were under way. Increased demand could not therefore be met by putting on extra girls, but only by higher production from the pieceworkers. To this end we made what are now called motion studies, an operation requiring the greatest tact. Varying rest periods, change of work so as to bring another set of muscles into play, height of seat and accessibility of components were all studied, with the result that we were satisfied that we did obtain the highest output per girl (paid for as piecework) that could be kept up day by day for a number of weeks. On one occasion the opportunity presented itself of working in circumstances in which the same girls, at their own wish, did even more, working for three days only per week. They kept this up for two weeks and then asked to give it up; the strain was too great and they found themselves tired for the rest of the week.

Overtime should be sparingly used for young persons; older men like it to provide a bonus for holiday occasions, but in the long run the same amount of work was done as if only normal hours had been worked.

Motion study under a special officer is to-day a regular practice, and much can be done to make the work easier. On the whole, operatives like monotony, something they can do with their fingers mechanically while they chatter and sing. They are suspicious of change unless they feel they have absolute confidence in the fair dealing of the management, and in particular a right of personal appeal to the top.

One of the most difficult things is to get hold of ideas from the workers to improve the process. There is the fear that the foreman will annex it as his own, or that if one goes past him that he will take it out of the individual. Suggestions boxes too often contain claims regarding alterations which the engineers already have in hand. The more management at the top knows the work-people, the easier it is to get a hint here and there where the shoe pinches, and to take equally quiet methods to put the trouble right.

Our wages were a few shillings above the local average, so that living on the same scale our people were just that amount better off. They were extraordinarily generous, as English working-people are, giving freely to help fellow-workers in adversity and to causes sponsored by us which commended themselves. Perhaps I should say that all this was largely before the advent of the cinema, which has done so much to absorb the loose shillings from the people's pockets.

We were always seeking methods of giving extra benefits to the work-people, partly as a means of profit sharing, partly to shield them in adversity, and partly also with the hope of retaining our labour and not having constantly to take on new people. This aim was achieved, for our labour turnover was one of the lowest in Great Britain. We were early in the field in granting holidays with pay, depending only on good time-keeping. We gave a weekly wage bonus for length of service. We started pensions depending on the will of the board—non-contributory because any fund on an actuarial basis would have been too costly. We postponed co-partnership because of fluctuating profits—workmen do not like the years in which no dividend is paid.

Perhaps our greatest success was group life insurance—every man of long enough service was given a policy for a year according in amount to his standing and the report on his general proficiency. The minimum was £100, and many workers had twice this. The realization by the married man that if anything happened to him his wife and children would receive what seemed a large sum—enough to start a small shop and keep them from want—had a profound effect on his well-being. The cost was considerable, but I am sure we should have been amply repaid.

Perhaps what has been said is enough to portray a restless management always seeking to make work happier for all and to better the lot of the worker both at work and at home. A loyal band of helpers found zest in the cause while our reward was close at hand. Needless to say we had no strikes, a very minimum of friction in spite of the fact that externally the years were very difficult ones, and a loyal response to any extra effort for which we asked.

The function of management *vis-à-vis* the worker is necessarily to drive, but when both sides understand each other, 'drive' becomes largely 'guide'.

E. F. A.

## PHYSICAL FEATURES OF COMET 1941*c* (DE KOCK)

R. H. STOY has described (*Mon. Not. Roy. Astro. Soc.*, 101, 7; 1941) the chief physical features from an examination of 24 plates taken with the Cape astrographic refractor on 18 days between January 20 and March 6. The plates were projected on to a piece of paper with the aid of an enlarging lens and a 500-watt lantern, the main features of the comet being then sketched in. The orientation of the drawing and position angles were derived from the lines, the positions of which were known, and when these had been completed an attempt was made to match the outlines of the observed caps by known curves.

It is interesting to notice that in nearly every case it was possible to find a catenary that fitted satisfactorily. There was a remarkable similarity between

the early appearance of this comet and Donati's Comet of 1858. Thus, Donati's Comet showed a dark division between the two principal tail streamers, and this feature was very pronounced in 1941c. The envelopes or caps were also very similar in both comets, and the shapes of most of these could be very satisfactorily represented by catenaries. In all these cases the departure from a catenary was in the sense that the observed curve was less divergent near its open end than was the catenary that fitted it best near its vertex.

This departure should indicate that the velocity of outflow from the nucleus of the matter forming these envelopes was steadily increasing, on the fountain theory of the formation of these caps, outlined by Eddington in *Mon. Not. Roy. Astro. Soc.*, 70, 442 (1910). It is remarkable, however, that the linear size of the caps did not increase from day to day, as would be expected on the fountain theory, which indicates that the velocity of outflow from the nucleus of the matter forming the envelopes should steadily increase. From January 20 until 28, the date of perihelion, the inner caps grew brighter as they got smaller, but there is not the same amount of evidence available for the outer caps. What there is shows that these outer caps seem to have remained much about the same size, or in some cases to have expanded slightly before starting to contract.

A full description is given of the phenomena visible on the plates for each day when photographs were taken.

## FIDDLER CRABS

JOCELYN CRANE has made important and interesting observations on these crabs ("Crabs of the Genus Uca from the West Coast of Central America." Eastern Pacific Expeditions of the New York Zoological Society. XXVI. *Zoologica*, 26, Part 3; Oct. 31, 1941). The present paper deals with specimens taken on the *Arcturus* Oceanographic Expedition (1925), on the Eastern Pacific *Zaca* Expedition (1937–1938) and on a special trip made to the Pacific shores of Panama by Miss Crane herself in January and February 1941.

The studies of habits and behaviour made on this last trip embrace a large amount of new knowledge on the ecology and especially the courtship display and mating of these crabs. Twenty-seven species are accurately described, eleven being new to science. There have been different opinions about the meaning of the waving of the large claw in fiddler crabs, but it is quite definitely established by these observations that this waving of the large claw, at any rate in the region investigated, is primarily for the attraction of the female, at least during the breeding season, and only secondarily for the warning off of crabs trespassing on a male's feeding range. This waving is only a part, or step, in a definite courtship display or dance which varies so greatly with the species that individuals can be recognized at a distance by their characteristic motions.

The patience which such studies necessitate is enormous, whole periods between tides being utilized and individual crabs kept under observation for many hours. The quality and quantity of the results show that such patience is amply rewarded, and Miss Crane is to be congratulated on the completion of a valuable contribution to the study of crab behaviour. Detailed colour notes are also given of all the crabs described; these colours vary enormously at the breeding season and at the time of display. "Courting adult males, in contrast to other adult males, and, of course, to females and young, change colour daily upon exposure to sunlight within the space of a short time—a few minutes to an hour or more being required. . . . That courtship coloration and display play a definite part in sexual recognition is certain, that they play one also in sexual selection is likely, but has not yet been proved by experiment."

A phylogenetic tree of the species dealt with is suggested and a key given to the species of Uca occurring on the west coast of America and in the Galapagos Islands.

## NATIVE SUBSISTENCE ON THE AMERICAN CENTRAL PLAINS

IN a recent paper, W. R. Wedel dealt with man's battle against Nature in the great plains of Kansas and Nebraska (*Smithson. Misc. Coll.*, 101, No. 3: "Environment and Native Subsistence Economics in the Central Great Plains". Publ. 3639. Pp. ii+29+5 plates. Washington, D.C.: Smithsonian Institution, 1941.) This region of widespread droughts, dust-storms, and consequent crop failures has been for some centuries the scene of attempted cultivation—sometimes successful, sometimes not. In view of recent failures the author has been collecting archæological evidence which tends to show that the aboriginal groups that exploited this region at various times and in various ways were themselves faced with similar adverse climatic conditions. In the western portion of this territory lies part of the High Plains province and immediately eastward of this is a stretch of sandy country now used for cattle rearing as the loose sandy soil renders it impracticable for agriculture on a large scale. Before the advent of the white man all this portion was roamed over by herds of bison, followed by nomadic tribes of Indians who preyed on them and on other abundant game. But farther east there is the great loess plain, fertile and well suited to agriculture and which was formerly inhabited by groups of Indians who cultivated the soil and made semi-permanent settlements. That these never became permanent was probably owing to the recurrent bad seasons—mainly droughts—that then, as now, might last for some years.

Archæological evidence goes to prove that groups of people did succeed at times in wresting a living even in the more inhospitable zones of the dry belt; as proved by sites containing the remains of charred corn and bone hoes, together with such quantities of animal bones as suggest that hunting was the main economy and horticulture a side line. In these circumstances the vagaries of the weather would play a less important part than in a wholly agricultural community. Droughts undoubtedly occurred in prehistoric times, the dust storms that accompanied them forming deposits over the sites.

In historic times great droughts occurred causing large population movements of the white settlers and reducing the Indians to the borderland of starvation. But it must be borne in mind that the old cultural patterns of the Indians were already broken by

contact with the whites and they had not had sufficient time to re-adapt themselves. It is likely that in pre-white times they might have weathered these droughts as they were of comparatively short duration, although severe.

The author came to the conclusion that it is unlikely that any major climatic change has taken place in the central great plains within the last thousand years, and that alternate settlement and abandonment of this area was as true of primitive man as it is of white man's tenure when large-scale government aid has not come to his rescue.

## EARTHQUAKE ORIGINS IN THE NEW ZEALAND REGION

R. C. HAYES, acting director of the Dominion Observatory, Wellington, New Zealand, has been investigating the origins of earthquakes in New Zealand ("Earthquake Origins in the New Zealand Region". Dominion Observatory Bulletin No. S.62). Using new material and improved methods, Hayes has redetermined the epicentres and depths of focus of several earthquakes in the New Zealand region for the years 1931 and 1936–40 inclusive, and has prepared a map showing these epicentres.

From these results it is evident that while the general distribution of earthquake epicentres does not differ appreciably from that indicated in earlier years, the more recent results bring out certain features which were not evident before. For example, the extensive seismic region, covering the eastern and southern parts of the North Island, Cook Strait area, and the northern part of the South Island is seen to have a sharply defined boundary on its north-west side, concave towards the north-west. It crosses the North Island from the Bay of Plenty to the region north of Cape Farewell, and there are very few earthquakes to the north-west of this line. Deep focus earthquakes may be significant.

Many of the shocks originating in the Gisborne – East Cape region and farther eastward have focal depths greater than normal. Origins at depths of 60 km. or more are common in the northern Hawke's Bay and Gisborne regions, the depths tending to increase up to about 100 km. for the submarine shocks farther eastward. Shocks originating in the south-west of South Island also have depths of focus of nearly 100 km. An isolated origin deeper than normal has been located near the north-eastern extremity of South Island (80 km.).

There is another zone, marked by origins at depths ranging up to 300 km. or more, which extends from near White Island in the Bay of Plenty to the region of Lake Taupo, a zone corresponding very closely with that in which volcanic activity occurs. The greatest depth of origin so far recorded in this zone is 320 km. (nearly 200 miles).

An important feature regarding the distribution of deep shocks which is indicated by the present results is their location with respect to the normal shocks in their vicinity. In most regions around the Pacific, deep-focus shocks tend to congregate away from the Pacific, the normal shocks being located on the Pacific side of them. This is clearly the case in the North Island of New Zealand, where the deep-focus zone has an extensive region of shallower or normal shocks to eastward of it.

## FORTHCOMING EVENTS

*(Meeting marked with an asterisk is open to the public.)*

### Monday, February 2

ROYAL SOCIETY OF ARTS (at John Adam Street, Adelphi, London, W.C.2), at 1.45 p.m.—Dr. B. A. Keen, F.R.S.: "Soil Physics, Theory and Practice" (Cantor Lectures, III).

ROYAL GEOGRAPHICAL SOCIETY (at Kensington Gore, London, S.W.7), at 3 p.m.—Dr. G. H. C. Hart: "Recent Development in the Netherlands Indies".

### Wednesday, February 4

ROYAL SOCIETY OF ARTS (at John Adam Street, Adelphi, London, W.C.2), at 1.45 p.m.—Mr. H. G. Jenkins: "Fluorescent Lighting".

### Thursday, February 5

ROYAL INSTITUTION (at 21 Albemarle Street, London, W.1), at 2.30 p.m.—Prof. A. W. Ashby: "The Rise of Efficiency in Agriculture".*

## APPOINTMENTS VACANT

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

DISTRIBUTION ENGINEER to the Tees Valley Water Board—The Engineer and General Manager, Water Board Offices, Corporation Road, Middlesbrough (February 5).

CHIEF ELECTRICAL ENGINEER AND MANAGER of the Accrington Electricity Undertaking—The Town Clerk, Town Hall, Accrington (February 9).

SECRETARY-STEWARD IN THE DEPARTMENT OF PATHOLOGY AND BACTERIOLOGY—The Secretary, Welsh National School of Medicine, 10 The Parade, Cardiff (February 10).

HEADMASTER of the King Edward VII School for Boys, Lytham—Messrs. Wilson, Wright and Wilsons, Clerks to the Governors, 6 Chapel Street, Preston, Lancs. (February 13).

MAN OR WOMAN TO TEACH MATHEMATICS AND MECHANICAL DRAWING—The Principal and Organizer of Further Education in Rugby, 61 Clifton Road, Rugby.

ASSISTANT MASTER in the Technical School of the Royal Aircraft Establishment to teach Mathematics, Mechanics and Machine Drawing—The Central Register (ONC 745), Queen Anne's Chambers, London, S.W.1.

## REPORTS and other PUBLICATIONS

*(not included in the monthly Books Supplement)*

### Great Britain and Ireland

Scientific Proceedings of the Royal Dublin Society. Vol. 22 (N.S.), No. 46: A Strain of the Tuber Blotch Virus causing Top Necrosis in Potato. By Phyllis E. M. Clinch. Pp. 435-445+plate 8. (Dublin: Hodges, Figgis and Co., Ltd.; London: Williams and Norgate, Ltd.) 1s. 6d. [61

British Chemical Plant. 1941 Official Directory. Pp. 190. (London: British Chemical Plant Manufacturers' Association.) Gratis. [91

A Twentieth Century Economic System. Pp. 60. (London: Economic Reform Club.) 6d. [121

Tin Research Institute. Publication No. 107: Hot-tinning 'Difficult' Mild Steels. By W. E. Hoare and H. Plummer. Pp. 28. (Greenford: Tin Research Institute.) Free. [121

### Other Countries

Smithsonian Institution: United States National Museum. Bulletin 50: The Birds of North and Middle America: a Descriptive Catalog of the Higher Groups, Genera, Species and Subspecies of Birds known to occur in North America, from the Arctic Lands to the Isthmus of Panama, the West Indies and other Islands of the Caribbean Sea, and the Galapagos Archipelago. By Robert Ridgway, continued by Herbert Friedmann. Part 9: Family Gruidae—The Cranes; Family Rallidae—The Rails, Coots and Gallinules; Family Heliornithidae—The Sungrebes; Family Eurypygidae—The Sun-bitterns. Pp. ix+254. (Washington, D.C.: Government Printing Office.) 40 cents. [11

Smithsonian Institution: Bureau of American Ethnology. Bulletin 131: Peachtree Mound and Village Site, Cherokee County, North Carolina. By Frank M. Setzler and Jesse D. Jennings; with Appendix: Skeletal Remains from the Peachtree Site, North Carolina, by T. D. Stewart. Pp. ix+103+50 plates. (Washington, D.C.: Government Printing Office.) 40 cents. [11

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