NATURE

No. 3898 SATURDAY, JULY 15, 1944 Vol. 154

CONTENTS

Editorial and Publishing Offices
MACMILLAN & CO., LTD.,
ST. MARTIN'S STREET, LONDON, W.C.2.
Telephone Number : Whitehall 8831
Telegrams : Phusis Lesquare London

Advertisements should be addressed to
T. G. Scott & Son, Ltd., Talbot House, 9 Arundel Street, London, W.C.2
Telephone : Temple Bar 1942

The annual subscription rate is £4 10 0, payable in advance, Inland or Abroad.

Registered as a Newspaper at the General Post Office

RESEARCH AND COLONIAL DEVELOPMENT

GIVEN a sufficiently detached perspective of the inception and trend of British Colonial development, one might well form an impression not differing greatly from that proceeding from a survey of the workings of human nature. There would be disclosed to one's view such elements as curiosity, adventure, courage, need, opportunism, foolishness, erratic behaviour, much remissness, and unwise discontinuity of effort ; but there would also be evident a real tenacity of purpose, a growing element of perception and constructiveness, together with a willingness to recognize past mistakes, and, not least, a determination to make good in the future. Those who are familiar with almost any one of our Colonies will be able to fill in the details of the mixed and not always laudable historical scene.

Whatever a review of the past may disclose, the keynote to the future is evident. In almost every Colony there is much to be done. The general problem of Colonial improvement is not a simple one : in each territory, according to its particular character, there are to-day many matters requiring more or less simultaneous consideration ; and the same holds good for these territories taken collectively. So the clamour for action arises on all sides. As obviously everything cannot be begun at once, those responsible for the administration of programmes of research and for welfare schemes have to face the questions : How to begin, and where ? A partial answer to these questions is given in two official documents just issued*.

In the First Annual Report of the Colonial Research Committee, some of the research schemes already approved are set out, together with a general survey of the fields that await attention. These last include topographical and geodetic surveys, geological research, fisheries, agriculture, animal health and forestry, medical research, the social sciences, industrial and archæological research. Not least, the important consideration of creating a cadre of men of science versed in Colonial problems is already being implemented by the institution of twenty-five Colonial research fellowships. This wide casting of the net and generous appreciation of what should be attempted through the medium of research towards the welfare and advancement of the Colonial Empire, at a period when the war effort is rising to its climax, is surely to be commended. Not only are these activities in our best administrative tradition, but coming at this particular time they should also do more than almost anything else to indicate to the outside world something of the essential national attitude to our overseas possessions.

It is true that these matters are for the most part still at the exploratory stage. But while any undue delay is to be deplored, the launching of new and

* Colonial Research Committee; First Annual Report 1943–44. (Cmd. 6535.) (London : H.M. Stationery Office, 1944.)
Colonial Development and Welfare Act, 1940. Return of Schemes made under the Colonial Development and Welfare Act, 1940, by the Secretary of State for the Colonies with the Concurrence of the Treasury in the Period from 1st April 1943 to 31st March 1944. (Cmd. 6532.) (London : H.M. Stationery Office, 1944.)

costly ventures without sufficient initial consideration would be not less harmful. Broadly speaking, the Committee has been concerned with two main aspects: first, with a review of the various fields of research together with a consideration of the central, regional and local organization required to deal with them; and secondly, with a scrutiny of specific schemes submitted for consideration.

In reviewing the general position, the Committee has been impressed with the need for providing, for each main branch of science, a co-ordinating centre to which proposals for research in that branch can be referred for expert scrutiny. "The Committee have therefore favoured the establishment of specialist Research Committees or Councils, which, in addition to being available for the provision of advice to the Secretary of State, would be in a position to be in direct communication with individuals, institutions or teams at work in the Colonies and so help break down the isolation noted in the Progress Report as a disadvantage suffered by Colonial research workers in the past."

As to the preparation of research programmes and decisions on priorities, the Committee has had to deal with the initial question of the distribution of responsibility and function between "the centre and the field, between London and Colonial Governments". It is recognized that no simple or uniform answer is possible. The various research councils and the Committee will serve in a purely advisory capacity to the Secretary of State: any authority in particular matters, such as the administration of a particular scheme, would be delegated by the Secretary of State or with his concurrence by some Colonial Government. The regional organization of research —a desirable feature—is also under consideration.

To those who rightly cherish and uphold the essential quality of freedom in science, the emphasis on planning and on the centralized scrutiny of research projects may perhaps raise doubts as to the general outlook. This issue is dealt with as follows: "The Committee feel bound to point out that whereas, rightly handled, regional organizations of this nature hold out excellent promise for good work and for a harmonious co-operation between workers in the field and the organizations which are being built up at the centre, it might also be possible by wrong organization to impede the flow of research which is the object of all. In their opinion, the conditions of success for the fruitful application of research to Colonial needs lie in the achievement and maintenance of a due balance between the greatest possible freedom of activity on the part of the research workers themselves, whether as individuals or as teams, and the proper allocation of the available resources of all kinds to the solution of the most urgent problems."

This attitude, if it can be maintained in practice, would appear to be sound. In all these anticipated developments one thing stands out clearly—the importance, at all levels, of securing the best men for particular jobs. This is recognized by the Committee. Whatever decisions may be reached as to the relations between central and regional organizations, between administrator and research worker, "the arrangements should be such as to attract and retain the services of research workers of adequate calibre. To this end, such workers should not feel that by working in and for the Colonies they are in any danger of falling behind the progress of their sciences, or of losing their chances of advancement therein. They should be able to maintain the freest possible contact with the advancement of science and with such institutions as exist, or may be created, for the co-ordination and dissemination of new knowledge. Furthermore, these workers must not be inhibited from working in the way best calculated to allow them to achieve the most valuable results, which means, in the field of scientific research as much as in any other sphere of creative activity, allowing the worker the greatest possible latitude as to his methods of work. Complete freedom of enquiry is not the only, but it is an essential, condition of fruitful research work." This aim of recruiting men of real talent, and of giving them freedom, scope, and reassurance as to the future, should be the subject of the widest publicity in all the universities and other educational institutions of Great Britain. Given such men, imbued with the ideal of service, we may look with confidence to a future fruitful in results.

The Report rightly directs attention to the part which local peoples may play in planning and guiding researches intended to enhance their own well-being. This would usually be done through Colonial Governments. Without doubt, one of the means of creating and maintaining an interest in research, and in due course of putting its findings into practice, will be to have work actually in progress in the territories concerned, and wherever possible to seek co-operation with interested local bodies. In this matter, the highly developed tradition of hospitability in Colonial life should do much to smooth the way.

The new Colonial research fellowships which are to be offered will almost certainly command wide attention and create stirrings in the minds of young men, who, after a longer or shorter spell of research at a university or kindred institution, may wish to adventure abroad. The aim is to create a cadre of men of science versed in Colonial problems. Many good results should follow the launching of this scheme; not least, the horizon of the scientific world will be enlarged by being familiarized with Colonial problems and the opportunities they afford for new lines of work. These fellowships will be "open to qualified scientists, whether in the natural or in the social sciences, to enable them to pursue research work in the Colonial Empire. The Fellowships will normally be for two years, and the Secretary of State hopes that Universities and other research institutes will be willing to grant applicants, if already members of their staffs, leave of absence for this period in order to enable them to take up the fellowships. Provision has been made for twenty-five such Fellowships within the next five years. It is recognized that war-time shortages of personnel will restrict the immediate applicability of the scheme; it is, however, being brought into force immediately, in case there are suitable candidates in any part of the Empire who are not at present required for urgent war-time work."

It may be said that the Research Committee takes a modest view of its activities. "The Committee are conscious that the list of specific researches approved since their Progress Report is short, and they would not wish it to be understood that they consider that the present rate of progress would be satisfactory in normal circumstances. But conditions are not normal, and, moreover, the Committee have been impressed by the fundamental importance, if a proper rate of progress is to be achieved when normal conditions return, of a sound basic organization. They have felt justified, therefore, in devoting the greater part of their attention to the problems of organization which have been described in this report."

The second document gives an idea of the many and varied schemes, including research, welfare and development, which have already been approved and are being financed (by free grants and loans) under the Colonial Development and Welfare Act (1940) up to March 31, 1944. Here the extent of support given to specific projects is set out. Food production, road-making, irrigation, agricultural development, water supplies, medical and health services, education, mosquito control, airfield construction, are only a sample of many items. Taken together, they afford a vivid impression of how vast and varied are the Colonial commitments of Britain and how much needs to be done, sometimes to make good overdue omissions, at other times to prepare for a brighter and better future. The battle with the tropics, which is unrelenting and has to be fought on many fronts, calls for all the weapons at our command. It is good to know that reinforcements are on the way.

EXPERIMENT AND THEORY IN PHYSICS

Experiment and Theory in Physics
By Prof. Max Born. Pp. iv+44. (Cambridge: At the University Press, 1943.) 2*s*. net.

THE question of the relation between theory and experiment in physics is one of perennial interest. It is, of course, only one aspect of the fundamental philosophical problem of the general relation of the rational to the empirical, and it is not too much to say that the peculiar character of progress in physics during the last generation has made it, for the time at any rate, the most important aspect of that problem. Certainly no one can contemplate the development during this century of both macroscopic and microscopic physics—relativity and quantum theory—without realizing that, whether or not his philosophical outlook has been modified thereby, its most appropriate expression must be very different from any which was possible previously.

We can no longer accept unquestioningly the naïve view that we are gradually learning the secrets of an objective world which exists in complete independence, undisturbed by our inspection and apprehension of it. We are bound to recognize that our activities, in theoretical physics at least, are not so much those of discoverers of unknown lands as those of creators of works of art. We do not look for the 'reality' behind experience, but seek to create a language in which the relations between our experiences can be most comprehensively and elegantly expressed. The statements of these relations are our 'Laws of Nature', and the question presents itself: Are these laws deducible only from experience itself, or are they *necessary* relations which could have been formulated, and recognized as relevant to experience, by a sufficiently powerful intelligence from pure reason alone, without reference to experience? The question, be it noted, implies the independence of reason and experience, for it contemplates the possibility that a being without experience might still reason effectively. We can evade any psychological objection that might be made to this assumption by supposing, if necessary, that our reasoner has had his reasoning faculties created or sharpened by experience which he has then completely forgotten. The question then remains: Could he formulate relations, to which any physical experience which he might afterwards acquire must conform, those relations being of the kind which we usually call laws of Nature and have in the past believed not to be derivable by reason alone?

The great majority of physicists, I believe, would answer this question in the negative, though they might be prepared to admit that the present formulation of physical laws owes more to reason and less to experience than we have been accustomed to assuming. Two outstanding thinkers, however—Sir Arthur Eddington and Prof. E. A. Milne—have independently given an affirmative answer. They do not necessarily deny the value of experience as a practical device for deriving the laws, or the possibility of factual details of experience which the laws cannot foretell; nor do they claim the perfection of intelligence needed for the rational deduction of the supposedly inevitable relations, though they do proceed some distance along the logical path and describe it quite differently. But they agree in asserting that the whole scheme of physical law, in an ultimately complete form, is attainable by reason alone, and so resurrect a type of philosophy which the scientifically minded since the time of Galileo and Newton have regarded as completely and irredeemably annihilated.

This phenomenon is justifiably regarded in many quarters with some apprehension, but even the darkest cloud has a silver lining, and when we read in Prof. Max Born's admirable little booklet that he has been induced to write it from his conviction that the ideas of Eddington and Milne are a considerable danger to the sound development of science, we are inclined to grant that the wayward astronomers might after all be forgiven, since their doctrines have produced so happy an issue. Prof. Born is in an almost unique position to write on this subject. Not only has he contributed some of the most vital ideas to modern physics, but also he has been in close touch with nearly, if not quite, all those others who have helped to create the atmosphere in which the philosophy of Eddington and Milne has been able to develop. He is thus both well aware of the measure in which the originators of the new ideas regard their work as dependent on experience, and particularly competent to form a trustworthy judgment on the general question. His conclusion is this: "I believe that there is no philosophical high-road in science, with epistemological signposts. No, we are in a jungle and find our way by trial and error, building our road *behind* us as we proceed. We do not *find* signposts at crossroads, but our own scouts *erect* them, to help the rest."

The course which Prof. Born follows is that of showing "the mutual relationship between theory and experiment in the actual historical development of science". After a brief introduction on the empirical character of geometry and astronomy and of the "experimental philosophy" of Galileo and Newton, he examines the more modern ideas which at first sight appear to have had an *a priori* origin. The various 'minimum' principles such as that of least action, Maxwell's electromagnetic theory, general relativity, matrix mechanics, wave mechanics, thermodynamical statistics, are discussed in turn, and the parts played in their development by theory and experiment are illustrated. Attention is then directed more specifically to the theories of Eddington and Milne, and the author arrives finally at the conclusion stated above. The writing is clear and vivid, and is interspersed with personal reminiscences and illuminating analogies.

To attempt a more detailed précis of this fascinating paper would be to weaken it; it should be read in its entirety. A more fitting commentary would be a brief discussion of a few of the points which its perusal suggests. Prof. Born hits the nail on the head when he says, on pp. 8–9, "The problem of physics is how the actual phenomena, as observed with the help of our sense organs aided by instruments, can be reduced to simple notions which are suited for precise measurement and used for the formulation of quantitative laws". If that is so, then it naturally follows that the production of equations out of our inner consciousness is something different from a solution of the problem of physics. Let Eddington and Milne give birth to their equations and, if they will, suggest a distinctive name for the activity in which they are engaged; nothing more need be said on the matter. Unfortunately, however, we tend unconsciously to forget this simple and accurate definition of physics, and fall back on the older, discredited assumption that there exist, independently of our experience or our reasoning, certain objective, self-sufficing things called 'Laws of Nature', and that experience and pure reason are alternative instruments by which, in physics, these laws of Nature may be apprehended. Even Prof. Born seems at times to lapse into this attitude, notably in the earlier portion of his essay. From that point of view we can argue until doomsday whether reason or experience is the better instrument, and no one will be a penny the better. If, instead, we simply use our reason to organize our experience into quantitative laws, all such argument is seen to be irrelevant, and we become physicists again.

A suggestive line of thought is opened up by the remark on p. 18 that "Heisenberg felt that quantities which had no direct relation to experiment ought to be eliminated". We must, of course, accept Prof. Born's statement about Heisenberg's feelings, for he and Heisenberg worked together on the problem referred to, but as a general rule the restriction to quantities *directly* related to experiment is surely too drastic. Probably the first consciously realized application of this principle, in modern physics at least, was that of Einstein to the question of motion through the ether. Here the earth had been assumed to have a definite, though unknown, velocity, and the value of Einstein's achievement lay in his recognition that because, by no experiment that could be devised, could this velocity be unambiguously determined, the existing scheme of physical concepts should be reformed so that this inaccessible quantity should no longer appear to have any significance. The justification for this reform, however, lay essentially in the fact that the earth's velocity could not be determined by *any* means. If it could have been found, by however tortuous a process, without introducing any contradiction into theoretical physics, the special theory of relativity would have fallen to the ground. No one would have been obstinate enough to ignore the value obtained because a series of metre rods had not been nailed to the ether along the earth's orbit and the hour angles of the mean sun observed when the earth coincided with its successive marks.

The only acceptable 'operational' principle in physics is that which demands that every concept used shall be related, in a strictly specifiable way, to possible measurements. Any narrower requirement than this leads to absurdity. Consider, for example, Avogadro's number. This is definitely related to experiment, for its value has been experimentally determined. The relation—to take one determination as an example—is that if one makes all the measurements involved in determining the temperature and density of a liquid and its vapour at an observed pressure, and the viscosity of the liquid, and combines the results in a particular way into a complicated expression, the value of this expression turns out to be a large number which is approximately the same for various gases. This we call 'Avogadro's number', and denote by the letter N. It is a perfectly legitimate concept because it is related to experiment through the measurements referred to. But now, when we introduce a particular hypothesis, namely, that a gas consists of a multitude of similar small moving particles called molecules, which are responsible, through the type of behaviour which we assign to them, for the pressure, temperature, etc., that we measure, we find that the pursuit of our ideas leads us to identify N with the number of molecules in unit volume of a gas. The direct experimental determination of a number of molecules, however, consists of a process of counting them, and this is impossible. Hence, if we define N as a certain power of the reciprocal of the kinematic viscosity per unit . . . per unit . . . etc., it is directly related to experiment; but if we define it as the number of molecules per unit volume of a gas under standard conditions, it is not. Heisenberg's feeling, then, should lead him only to substitute a cumbrous for a simple name, while leaving the practice and the mathematical structure of physics unchanged. It is difficult to regard such an achievement with admiration.

In considering the legitimacy or otherwise of a physical concept, we must, then, ignore all hypotheses or theories which give a picturable significance to the concept, and take into account only its relation to actual operations of measurement. The hypotheses may be, and in practice are, essential for making progress, but they have no bearing on the question whether the concept may be used in physics or not. For this reason I find it difficult to agree with Prof. Born's view that operational definition "comes to grief in quantum theory". It is true that in that theory symbols are used of which we have not been able to give picturable correlatives, though Prof. Born's own invaluable interpretation of one of them as representing a probability should remind us that this is not necessarily a permanent characteristic. But an operational definition is not identical with a picturable metaphor; it is simply an expression of

the relation of the mathematical symbol, in its mathematical context, to measurable quantities, and this is possible in quantum theory as in any other part of physics. The remoteness of the relation has nothing to do with the matter, and may in any case disappear overnight when someone thinks of a new analogy.

Milne's claim that his theory obeys the operational principle raises objections of somewhat different character. In so far as an operation can be described which, if carried out, would yield numbers for the symbols he employs, those symbols may be said to be operationally defined. The trouble is that, for practical reasons, we can get no further than a description of the operations; actually to perform them we should require infinite time, an infinite army of slaves or disciples whom we could transport where we wished, and apparatus of infinite delicacy, to say nothing of the absence of any unsuspected difficulties throughout the great distances and durations involved. This would be of little consequence if it prevented only the final verification of a theory made probable by other observations, but in Milne's theory it is the very first requirement. Until these impossible demands are satisfied, physics cannot begin. Any agreement with observation that the theory might claim must therefore be obtained by departing from the operational definitions. Many, like Prof. Born, will "not wish to discourage anybody who feels in himself the vocation to embark on so adventurous a journey", but they will themselves prefer to see what can be done with measurements that can not only be conceived but actually made.

Like others, Prof. Born has not succeeded in understanding the essential parts of Eddington's theory connecting the constants of quantum theory with those of cosmology. That is not to say that there is nothing of great value in the theory. His final comment is perhaps the wisest that has yet been made on this subject: "I am far from attacking Eddington's theories or from doubting his results. If they should turn out to be right I shall rejoice. But I shall not attribute this (possible) success to Eddington's philosophy, as a doctrine which could be followed by others, but to his personal genius and intuition." HERBERT DINGLE.

POLLEN ANALYSIS

An Introduction to Pollen Analysis

By Dr. G. Erdtman. (A New Series of Plant Science Books, Vol. 12.) Pp. xvi+240. (Waltham, Mass.: Chronica Botanica Co.; London: Wm. Dawson and Sons, Ltd., 1943.) 5 dollars.

POLLEN analysis is the term applied to the quantitative analysis of material containing pollen, by microscopic recognition of the species and genera of plants from which the pollen came. The pollen membranes have qualities of shape, size, surface, and structure which permit these identifications, and their preservation is often excellent.

It was G. Erdtman, a Swede, who in the nineteen-twenties, by a series of papers written in English, introduced British and American scientific men to the principles and technique of pollen analysis, a new method of geological inquiry which had recently been developed in Scandinavia, particularly by the energy and insight of L. von Post. The succeeding years have seen a very great extension of the applications of pollen analysis. Not only has it been used in countries in all parts of the world to elucidate their forest history, and thence the drift of former climatic conditions, but also it has been shown to afford the means of solving an unexpectedly wide range of problems. Thus, by the analysis of ice in the various layers of the great alpine Aletsch glacier, Vareschi has been able to recognize the regular seasonal alternation of preserved pollen, and on this basis has made important deductions about the character of glacier structure and movement. In the Swiss Alps, in the eastern United States, and recently in South Wales, analyses of the pollen content of the air at different seasons have proved valuable in studies of hay-fever.

It has long been recognized that dating of prehistoric objects and structures found in lake- or bog-deposits is often possible by reference to the geochronological scale afforded by the regular drift of forest history. Similarly, the course of relative movement of land- and sea-level may be effectively dated, and eustatic effects distinguished from isostatic. More recently, it has become apparent that not only is the former distribution of natural plant communities reflected by pollen analyses, so that the conditions of salt-marsh, lake, fen, forest and bog may be accurately recognized in buried layers, but also, as Iverson has shown (see *Nature*, April 29, p. 511), the influence of prehistoric man in modifying natural communities may be detected, together with the origin of the new anthropogenous vegetation he has created.

Hitherto no text-book of pollen analysis has been available, and we warmly welcome, therefore, the appearance of the "Introduction to Pollen Analysis" by Dr. Erdtman. He has himself in the last twenty years contributed important results to the field of pollen analysis. He has developed a technique of preparation by chlorination and acid-hydrolysis which very greatly simplifies counting of grains in materials poor in pollen: he has sharpened the technique of critical recognition of species by their pollen morphology, and he has contributed much to the knowledge of long-distance flight of pollen. In this book these matters are given adequate treatment, together with such related topics as the analysis of pollen in honey as a basis for determination of the country and season of its origin, and the geological use of spore-counts in coal seams.

The greater part of the book is nevertheless devoted to description of the morphology of a wide selection of pollen grains and spores, and of these very numerous drawings are given—very usefully all upon the same scale. The types included are largely north-west European, but a sprinkling of North American and other species is also included. The atlas of twenty-eight plates thus provided is certain to be of the greatest value to all who study pollen analysis.

There is still much to be written of the results of application of pollen analysis to recent geology, and we may perhaps feel that this field has been a little neglected by Dr. Erdtman; but it has been his purpose to direct study to the widest scope possible, and in this he has certainly succeeded. Both he and *Chronica Botanica* are to be congratulated on the easy and natural English of the book: many others deserve credit for having enabled production of the book to be carried through during a world war, with the author still in Sweden and his publishers in the United States. H. GODWIN.

THE RUGBY EXPERIMENT

From Learning to Earning

Birth and Growth of a Young People's College. By P. I. Kitchen. Pp. 168. (London: Faber and Faber, Ltd., 1944.) 8s. 6d. net.

THE establishment in due course of young people's colleges having almost become the law of the land, this book could not have appeared at a more opportune moment. In a general way, the story it tells is well known. In a couple of years, the day continuation school clauses of the Act of 1918 became, at any rate in the sense in which their author meant them, a dead letter—except at Rugby. The story with its sequel is here set forth by Mr. Kitchen, who since 1919 has been principal of Rugby College of Technology and Arts, and organizer of further education at Rugby. He describes his book as a simple account of a small-scale experiment for assisting youth in its dangerous crossing over the no-man's land between school and work, and he hopes its realism may prove a refreshing contrast to the chorus of reconstruction programmes now emanating from the idealists.

The Lewis Committee of 1917 reported the occupations of children of 14 plus as amounting to a small proportion of apprenticeships and a large proportion of blind-alley jobs and seasonal work—a fruitful source of juvenile delinquency. The Committee confidently recommended compulsory day continuation schools, and the recommendation was adopted by Mr. Fisher in the following year. (It may be observed that the dismal account given by Mr. Herbert Lewis's Committee in 1917 is just as true in 1944.) Appointed days were fixed in a few places, of which Rugby was one, for the operation of the clauses in the Act which made attendance at continuation schools compulsory. Rugby's appointed day was April 13, 1920, and Rugby proceeded with its preparations.

An enthusiastic staff resolved to give the go-by to the old order of marks, examinations, reports, competitions, rewards and punishments, and to create a new order in which control was to be self-control, and discipline a disreputable word. The guiding principle was free activity, and precious time was not to be wasted on vocational education. To cut a long story short, the scheme received an unexpected shock. It satisfied nobody. With employers murmuring, parents dissatisfied, public opinion uneasy, and young people themselves "overdosed with high lights, play and freedom", the programme of the compulsory day was replanned on the old lines, and freedom was reserved for voluntary evening work, where it thrived. A modern curriculum was eventually devised, of which the underlying principles will no doubt receive careful attention in many other places besides Rugby.

But Rugby's decision to stand alone as the pioneer compulsory day continuation school was likely to incur criticism and animosity, and a hard struggle ensued, especially after the promising London attempt and the Kent scheme both had to be abandoned. The school was, of course, an isolated institution, and was regarded by some as a mere curiosity, but by the more far-seeing as a possible "spring-board for a second forward movement, better timed and more carefully prepared, with a more successful issue". The author adds an account of the birth and growth of the technical and art school; and it is to be noted that the Rugby experiment is entirely favourable to the association of all forms of part-time schooling in one college building, with all types of pupils learning and growing together. "All gain much by the example of and contact with others, old or young, bright or dull, ambitious or indifferent, engineers or artists, conscripted or voluntary, scholarship or paying pupils."

The story of the Rugby experiment needed to be told, and it is most fortunate that the story has been told so worthily. The total impression left upon the attentive reader is quite clear, and there is not a dull sentence in the book. A good deal of it is a record of a real fight, a struggle for existence, in which the more enlightened employers and parents, and the practical support of the great school near by, helped to secure a victory.

T. RAYMONT.

EVOLUTION OF A LAND POLICY

The Arkansas Plantation, 1920-1942

By Donald Crichton Alexander. (Patterson Prize Essays, Yale University, Vol. 2.) Pp. 118. (New Haven, Conn.: Yale University Press; London: Oxford University Press, 1943.) 6s. 6d. net.

THIS ably written essay deals with far wider issues than its title suggests. It reviews the disastrous condition into which American agriculture in general, and the cotton-growing industry in particular, fell between the two World Wars, and the gradual evolution of measures to remedy this. The United States had become a creditor nation, and she failed to realize that a policy of high industrial tariffs was limiting trade with her neighbours. The tariffs maintained industrial prosperity for a time but aggravated the agricultural depression. Huge stocks of cotton accumulated and growers went bankrupt.

An account is given of the dismal failure of the Harding, Coolidge and Hoover administrations to understand and deal with the problem. Under Roosevelt, effective action was taken and an Agricultural Adjustment Act was passed; but in 1936 the Supreme Court announced that it was unconstitutional. Soil conservation had been a secondary objective in this Act, but under a new Soil Conservation and Domestic Allotment Act passed in 1936 it took first place. According to Mr. Henry Wallace, the Act had five objectives: "Preservation of soil fertility, diminution of soil exploitation, promotion of the economic use of land, the protection of rivers and harbours against the results of soil erosion and the attainment of parity income for agriculture". This Act failed as a means of acreage control, and a second Agricultural Adjustment Act was passed in 1938 in which preservation of soil resources is still a basic objective. Another interesting point is that it contains provisions designed to gain a wider market for the farmer; these include the establishment of four regional laboratories for research and development of new uses for farm products, a scheme that might very profitably be studied in Britain.

The author's easy and lucid style makes the book a pleasure to read, and in view of the difficulties through which British agricultural industry has been passing it will be of interest to many who are concerned with farming.

It is to be hoped that in framing our own agricultural policy due consideration will be given to that most important factor, the maintenance of soil fertility, and that attention will be directed to research on improved and new uses for agricultural products.

W. G. OGG.

LIGHTNING CALCULATIONS WITH LIGHT*

By SIR LAWRENCE BRAGG, O.B.E., F.R.S.

WHEN we attempt to infer the positions of the atoms in a crystalline structure from measurements of X-ray diffraction, all methods reduce in principle to a matter of 'trial and error'. The investigator tentatively places the atoms in certain positions, using judgment and past experience to set up an arrangement which does not conflict with interatomic distances and probable groupings. He then calculates how such an arrangement would diffract X-rays, and makes a comparison with what is observed. If there is no correspondence, he must try again. By eliminating possibilities and by adjustments of any structure which shows hopeful signs of checking with observations, he finally arrives (if successful) at an arrangement which he can regard as established. All this involves an immense amount of calculation. He may, for example, make measurements of a thousand diffracted beams. For each model, he must calculate the intensities of diffraction and compare it with what is observed. When the structure is complex, containing many atoms, there are so many possible permutations and combinations of the atomic positions that considerable courage and perseverance are necessary. A structure of a new type, such as a complex silicate or an organic molecule such as a sugar, has often meant one or two years of hard work and the accumulation of drawers full of calculations. The labour is well repaid, because so often a new structure casts quite a new light on an important chemical problem. Any method, however, of reducing the labours of calculation, and so saving the time of the expert, is of value.

I wish in this account to describe some methods of making light do our calculations for us. These methods are not so precise as those of computation, at any rate as yet. They are rough and ready, but quick, and I think they are promising and may be developed into a really useful tool. It is as if we were doing an approximate sum with a slide rule, to see whether the answer is about right, before turning to the logarithm tables for a more precise calculation. I have therefore called this discourse "Lightning Calculations with Light".

The 'Fly's Eye'

Perhaps the most simple example with which to start is one which in point of fact has been one of the latest to be developed. I showed the first examples of it at a Royal Institution discourse in 1942. In X-ray analysis, it is usual to consider projections of the crystal pattern on certain planes for the sake of simplicity, so breaking down the diffraction problem into a two-dimensional one. It is familiar to workers in this field that the reflexions of X-rays by planes belonging to a zone (parallel to some crystallographic direction) simulate in their intensity the spectra which would be produced if light fell on a cross grating; the pattern of the cross grating is that of the crystal structure projected in a plane perpendicular to the zone axis. If therefore we can make a cross grating with a pattern like that of the crystal when viewed in a given direction, and use it to diffract monochromatic light, we should see a pattern of spectra which are bright or dim in accordance with the corresponding X-ray spectra; for example, an array of spots corresponding to all the $hk0$ reflexions if the zone is the c axis.

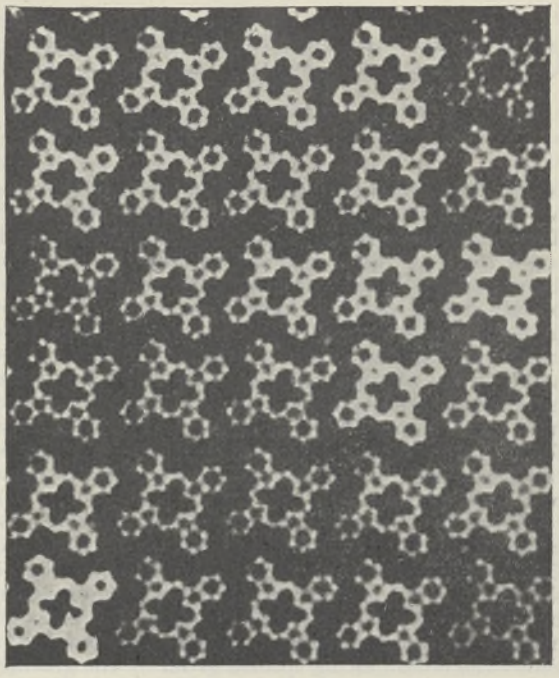


FIG. 1. MICROPHOTOGRAPH OF CROSS GRATING PRODUCED BY THE 'FLY'S EYE'. (BUNN.)

It would be possible to draw the crystal pattern on a large scale, and photograph it down so as to make a cross grating; but this would be tedious. The 'fly's eye' device makes the construction of the grating a simple matter. A master plate is prepared which consists of a pattern of minute transparent holes 0·04 mm. in diameter in an opaque background. The plate is the negative of a large-scale pattern of

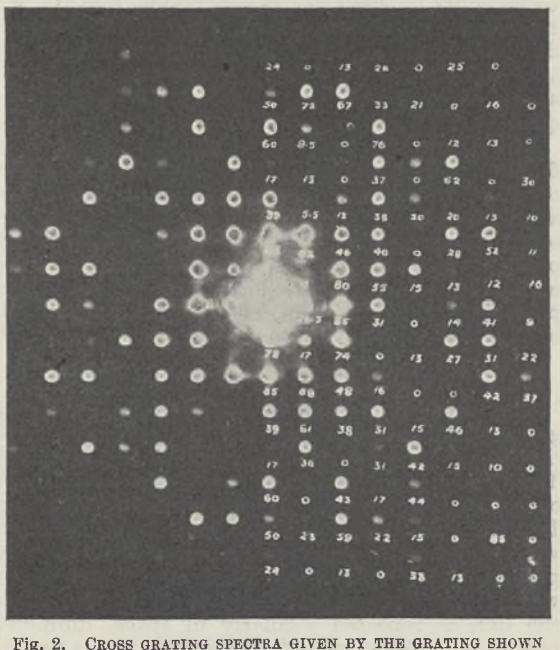


FIG. 2. CROSS GRATING SPECTRA GIVEN BY THE GRATING SHOWN IN FIG. 1. (BUNN.)

* Friday evening discourse at the Royal Institution on March 24.

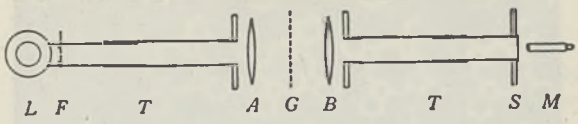


Fig. 3.

black spots which is photographed down. The holes are spaced about 40 to the centimetre each way. The master plate is laid on a photographic plate with small distance pieces which keep the two surfaces 1 mm. apart. The plate is exposed to a single unit of the crystal pattern, represented by a cluster of lamps at a distance of about one metre; each hole in the master plate throws a pinhole image of the array on the photographic plate, so that the pattern is repeated for every hole. The plate is developed and used as a cross grating. A convenient method is to focus a telescope on a pinhole source of monochromatic light, and place the cross grating in front of the objective.

The method has been greatly improved by Bunn, working in the research laboratory of Imperial Chemical Industries, Ltd., at Northwich. Fig. 1 shows a microphotograph of a cross grating produced by the 'fly's eye'. The units represent the phthalocyanine molecule as determined by Robertson. Fig. 2 shows the cross grating spectra given by the grating, and the numbers represent the strength of the observed X-ray spectra. It will be seen that the correspondence is quite encouraging. The holes in the master plate were in this case at the corners of squares, whereas the unit cell of the crystal projection had no such simple symmetry. However, provided the atoms in the pattern unit have the right co-ordinates expressed as fractions of the cell edges, the interference pattern should check with the X-ray results. The grating in this case was made by moving a single lamp to successive positions of the carbon atoms in the structure unit, and taking an exposure for each position. Since the effective atoms are all carbon and nitrogen, they can be taken to be equal in scattering power. Some research will be necessary to reproduce a pattern of atoms of different kinds in a correct quantitative way, but trial and error will no doubt enable one to arrive at a set of empirical rules which lead to the right quantitative results.

The procedure for crystal analysis is thus as follows. Any proposed structure which is to be tested is drawn to scale, and a lamp placed at each atom in turn. If a number of variants are tried, a series of corresponding cross gratings can easily be photographed side by side on the same plate since each is less than 1 cm. square. By viewing a pinpoint light through them, one can see immediately if any one of them is near the truth.

The Molecular Scattering Factor

The strength of each diffracted beam in a cross grating pattern is determined by the amount scattered by the unit of pattern in that particular direction. The amount scattered by a single unit is a continuous function of the direction of scattering. In the two-dimensional problem, this function, which is the molecular scattering factor, may be plotted by using contour lines to outline places where it is strong and where it is weak. When the unit is repeated regularly in space, diffracted beams only appear in certain directions (cross grating spectra). If therefore we superimpose on the graph representing the structure factor a grid such that its intersections represent the positions of the spectra, whenever a spectrum falls on a high contour it will be strong and when it falls on a low one it will be weak.

Fig. 3 shows the apparatus for calculating molecular structure factors by using light interference. A pinhole is placed at F, at the focus of the lens A. Light from a lamp L passing through the pinhole is made parallel by A, and passes through a screen G which has a pattern of holes representing the pattern of atoms in the structural unit. A second lens B is identical with A, its focus being at S. The light waves from the holes in the screen G interfere to build up at S a pattern representing the molecular scattering factor, which can be viewed through the microscope M.

Instead, therefore, of building up a complete cross grating as in the 'fly's eye' method, we merely make up a single unit of pattern, representing the atoms by holes in the screen at G. A photograph is taken of

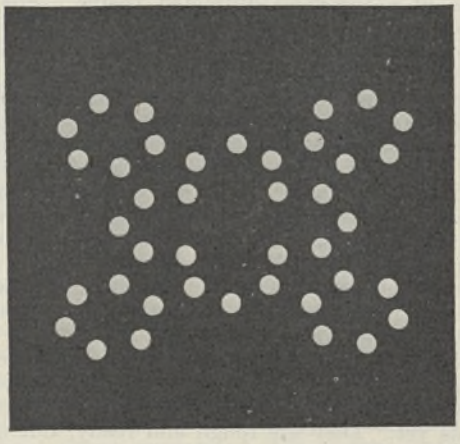


FIG. 4 (*a*).

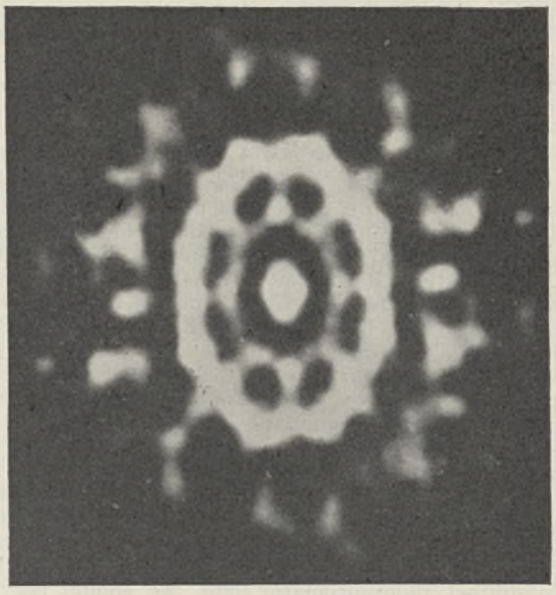


FIG. 4 (*b*).

Fig. 4. (*a*) PHTHALOCYANINE MOLECULE. (*b*) MOLECULAR SCATTERING FACTOR. (FOR COMPARISON WITH (*a*) REVERSE RIGHT TO LEFT.)

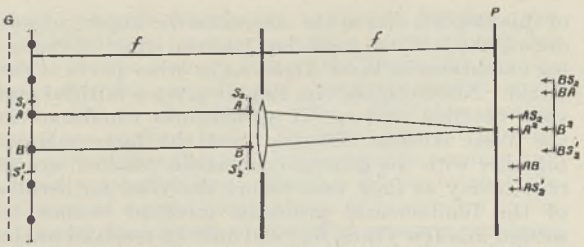


Fig. 5. THE CONSTRUCTION OF A PATTERSON DIAGRAM BY ROBERTSON'S METHOD.

the consequent diffraction pattern at S. This is enlarged, and covered by a grid to the right scale which defines the positions of the cross grating spectra. A comparison is now made with a diagram setting out the strength of the observed X-ray beams, plotted to the same scale. If strong and weak X-ray beams correspond to points on the grid where the diffraction pattern is strong and weak respectively, the right pattern unit has been found. Fig. 4*b* shows the molecular scattering factor of the phthalocyanine unit represented in Fig. 4*a*. The fringe pattern before enlargement is about 2 mm. in diameter.

Patterson Synthesis

The 'Patterson' or 'Vector' diagram is much used in X-ray analysis. We may consider the projection of a crystal on a given plane for the sake of simplicity, though the principle is the same in three dimensions. The electric density of the unit of pattern, projected on a plane, can be represented by a set of contour lines like those on a map which give heights. Such diagrams will be familiar to anyone who has followed the later developments of X-ray analysis. They give the density $\rho(x,y)$ at any point x,y in the unit cell. The Patterson diagram is more complex. It is a plot of a function $P(x_0,y_0)$ which at the point x_0y_0 has the value of the double integral taken over the unit cell.

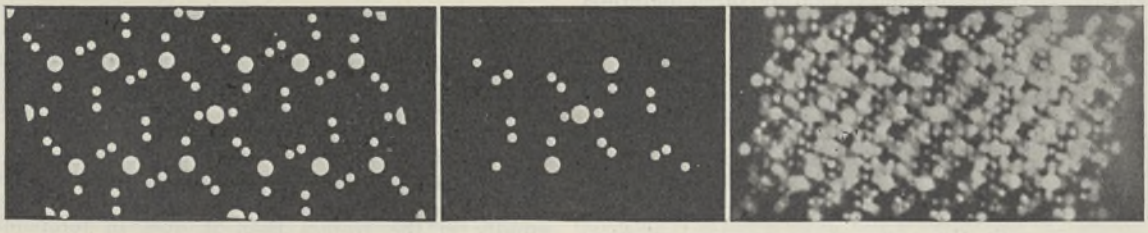
$$\iint \rho(x,y).\,\rho(x + x_0,\, y + y_0)dxdy.$$

It is called a vector diagram because its peaks represent vector relationships between the atoms in the pattern unit. If there is an atom at $x'y'$, and another at $x' + x_0$, $y' + y_0$, the densities will be large around both these points, and so the integral will have a large value around the point $x_0\, y_0$ in the Patterson. Every pair of atoms gives a peak. There is a large peak at the origin, since each atom multiplies itself, so to speak, at this point. The Patterson is complex, because if there are n atoms in the unit cell there are n^2 superimposed Patterson peaks, of which n are at the origin. The advantage of the Patterson is that it can be formed directly from the observed X-ray results, in a way indicated in the next paragraph. It often gives a clue to the positions of outstandingly heavy atoms in the structure, or to repeated vector relationships.

Robertson[1] has recently published an ingenious method of constructing the Patterson, given the crystal structure. A variant of his method referred to briefly at the end of his paper is illustrated in Fig. 5. Hägg[2] has suggested a similar method. To get the Patterson, we must (so to speak) multiply the crystal structure by itself.

The atoms in the unit of pattern $S_1S'_1$ are represented by holes in an opaque plate. These appear again at $S_2S'_2$, which is in contact with a long-focus lens. The distances S_1S_2, S_2P are equal to the focal length. $S_1S'_1$ is backed with an illuminated sheet of ground glass G. The Patterson pattern appears on the screen P. The light coming through each hole such as A multiplies the complete pattern at $S_2S'_2$ and throws it on the screen in such a way that A^2 appears at the focus F, the origin, while AB, AC, etc., appear in their proper vector relationship to the origin. Similarly, another atom B produces B^2 at F, whereas BA, BC, etc., appear in their vector relationship. Fig. 6*a* and *b* show the two screens for the case of $CuSO_4.5H_2O$ projected on the *b* plane, and Fig. 6*c* the resulting Patterson. Alternatively, the lens can be dispensed with by making $S_2S'_2$ on half the scale of $S_1S'_1$.

If therefore the Patterson has been formed from the X-ray results, and we wish to check if a postulated crystal structure gives the same Patterson pattern, we need not calculate the latter. It is sufficient to reproduce the pattern at S_1 and S_2, and use the arrangement of Fig. 5.



(*a*) (*b*) (*c*)

Fig. 6. (*a*) FIRST SCREEN FOR PATTERSON CONSTRUCTION ($CuSO_4.5H_2O$, *b* PROJECTION). (*b*) SECOND SCREEN FOR PATTERSON CONSTRUCTION. (*c*) THE PATTERSON PATTERN. (FOR COMPARISON WITH (*a*) AND (*b*) REVERSE RIGHT TO LEFT.)

Certain precautions have to be taken. An atom in the pattern unit at S_2 which appears at a corner of the cell must be quarter strength, one on an edge half strength, and S_2 should be a single unit cell. S_1 can be a repeated pattern. In this way the final result at S will have the correct overlapping of peaks of the right strength.

Building up Fringes

For the sake of completeness reference may be made to the building up of a crystal image by superposition of fringes, though it will not be described here as it has been published elsewhere[3]. Referring to Fig. 3, if two small holes are made in the screen at G, a series of fringes will appear at S. The amplitude of the fringes is determined by the size of the holes, their orientation is at right angles to the line joining the holes, and their spacing is inversely proportional to the distance between the holes. We can therefore superimpose at S any series of fringes by making the corresponding holes in G. The only

variable not conveniently at our command is their phase. Now the Patterson of a crystal can be built up by superimposing elements of a Fourier series, all of which are in phase at the origin or cell corners. The elements of the series are proportional to the measured X-ray intensities. If therefore holes are drilled in the screen G to represent, as cross grating spectra, the intensities of the observed X-ray spectra, the result at F is the Patterson diagram which light has calculated for us from the X-ray results. An example is given in the second article quoted above.

These methods of calculation are as yet in their initial stages, and much remains to be done to perfect them. The success already obtained, in particular with the 'fly's eye' method, is, however, quite promising and they may well prove to be a useful additional weapon in the X-ray analyst's armoury.

[1] *Nature*, **152**, 411 (1943).
[2] *Nature*, **153**, 81 (1944).
[3] *Nature*, **143**, 678 (April 22, 1939); **149**, 470 (April 25, 1942).

WEST AFRICAN AGRICULTURE

By SIR GEOFFREY EVANS, C.I.E.
Royal Botanic Gardens, Kew

IN the spring of 1938 the Trustees of the Leverhulme Trust invited four members of Parliament to visit West Africa and report upon conditions in the West African Colonies generally. The terms of reference included a study of the standard of life of the native population, the production of food and other materials and in particular certain problems in respect of the development of agriculture, pastoral work and forestry. The investigations considered the problem of the improvement of farming methods and the introduction of new crops; the study of export crops, forestry and animal husbandry and the general problem of soil conditions, including erosion and improvement by better methods of cultivation. Lastly, the existing systems of land tenure were examined with the view of ascertaining whether modifications would be likely to be advantageous in the fullest development of the land. These objects were distinct from the more political aspects of the work of the Commission, and for the purpose of the inquiry certain technical experts were attached. The Technical Reports of the Commission have now been published; that on crop production and soil fertility is a valuable and informative document*. The Commissioners in their foreword to the Report lay down a principle—with which all who have acquaintance with these territories will agree—that any future economic development must be based on the fundamental importance of farming as the major interest of the African people. In view of this the Leverhulme Trust was fortunate in securing the services of such eminent men of science as Mr. H. C. Sampson, with his unrivalled knowledge of agricultural problems in India and East Africa; and Dr. E. M. Crowther, head of the Chemistry Department of Rothamsted, who is an acknowledged authority on tropical soil problems.

The outbreak of hostilities delayed the publication of this Report, and in the meantime the impact of war during the last five years has had the effect of changing conditions in West Africa as in other parts of the world. Nevertheless, the Report gives a faithful and very detailed account of agricultural conditions in the West African Colonies, and the facts related, together with the general conclusions reached, are as true to-day as they were before the War, for certain of the fundamental problems involved cannot be settled in a few years, but will only be resolved as the result of a well-planned and carefully thought out policy applied over a number of years.

The need for organizing research and survey on a much larger scale is stressed with the objective of working out an ecological interpretation of the country and its mode of life. That such surveys are needed is generally conceded, but progress in this direction has been hampered by lack of trained staff. The most striking piece of work hitherto has been achieved in the extreme north of the Northern Territories of the Gold Coast. Here a detailed ecological survey of the thickly populated strip of country comprising the granitic soils of the Dagombo peoples has been followed by the application of a definite system of improved agricultural methods. Elsewhere this principle has been adopted in a more piecemeal manner, but it may be said that in all cases where definite progress has been made, it has always followed the preliminary study of native methods of cultivation and has usually resulted in the grafting of the improved methods on to the native systems rather than the introduction of completely novel methods.

The section on geology and soils forms a valuable addition to our knowledge, and it is worth the study of all officers, administrative as well as agricultural, for the improvement, and, in the final instance, the saving of the soil, is the basis of all agricultural prosperity. The interesting suggestion is put forward that many of the traditional agricultural practices are to be explained in terms of the mineral nutrients necessary for plant life. Generally speaking, it may be said that West African soils are not particularly fertile, and indeed in large areas they are definitely poor. Organic matter decomposes much more rapidly in the tropics than it does in temperate climates, and many of the soils in the dry tropics are short of humus. Most of the surface soils in the wet zone are very deficient in bases and notably lime, phosphates, and potash; an exception being the rich volcanic country around the Cameroon Mountain.

The general shortage of lime is evident in many ways. Thus the native cattle and wild animals are smaller in the wet areas, where the lime and other minerals are readily leached out of the soil by the heavy rain, than in the dryer zones to the north. In the forest areas where cattle can with difficulty live owing to the attentions of the tsetse fly, the application of farmyard manure is not practicable, and experiments are now being conducted by the Agricultural Departments in Nigeria, in particular, to try to replenish the surface soils by means of the residues of certain deep-rooted shrubs which it is believed will draw these mineral nutrients from the subsoil. There are large areas in the country east of the Niger where the soil is so poor that it is impossible to establish a leguminous cover crop, and it is presumed that this is due to the lack of essential minerals. The present custom of cutting and burning the bush, growing a couple of crops and then allowing the land to recover by reverting to bush for a long series of

* The West Africa Commission, 1938–39. Technical Reports. 1. Crop Production and Soil Fertility. By H. C. Sampson and Dr. E. M. Crowther. (London: Leverhulme Trust.)

years, although destructive to timber supplies, was fairly effective so long as there was a sparse population. But in the Ibo country east of the Niger, the population is increasing rapidly and already in some districts it is 1,200 to the square mile. Here the resting period has perforce had to be reduced to two or even one year, so that this land has no time to recover and is rapidly deteriorating. There is no doubt that the evolution of a permanent system of husbandry in the wet forest area is one of the most pressing problems and also one of the most difficult to solve. It is a matter requiring careful and continuous investigation over a series of years. It is believed that these deep-rooted species, such as the rosaceous shrub *Acioa barteri*, bring up nutrients from the subsoil, but there seems to be no definite knowledge with regard to the extent to which this occurs, and detailed information would be advantageous. A central research station to deal with these problems of cultivation in the Forest Belt is badly needed, since a solution is probably the most urgent of all tropical agricultural problems at present.

In the drier parts of the country where it is possible to keep livestock, considerable progress has been made in establishing systems of mixed farming, whereby farmyard manure becomes available for the replenishment of the soil.

Somewhat remarkable results have been obtained by the application of dressings of one or two tons an acre. Such light applications would be considered homœopathic in Great Britain, and an interesting theory is put forward that the increase in yield may be due, in the main, to the minerals and not so much to the humic content of the manure. Further trials with mineral fertilizers are advocated. Phosphates in particular appear to be short, and it is pointed out that whereas rock phosphates may give good results in the acid soils of the Forest Belt, the more soluble fertilizers such as superphosphate may give better results in the neutral soils of the north. The argument that the peasant is so poor and so conservative that he will never readily take to artificial fertilizers is really unsound. In India the *ryot*, who was always considered one of the most conservative of beings, now uses large quantities, but he had to be converted to the value of the practice by prolonged and visual demonstrations. It must also be remembered that large numbers of African peasants have joined the Armed Forces during the last four years and have gained a measure of education and a widening of outlook which will undoubtedly have a big effect on village life when they return after demobilization. All these men will have travelled a good deal and will have learnt a lot from their contact with other peoples and other countries. Most of them have learnt to think for themselves, and will be quicker to take up any new method which promises to be advantageous.

As has already been mentioned, the African soils are deficient in certain important plant foods. The discovery of good deposits of agricultural lime or a reef of good phosphatic rock would be of untold benefit. There are phosphatic rocks in the Yoruba country, but there is no factory for making superphosphates. As it is at present, the country is losing most of its minerals through the export crops such as oil seeds and cacao. The north is also losing vast quantities in the shape of its cattle and animal products. If means could be found to slaughter the cattle in the north instead of sending them down to the coast on the hoof, the bones, horns and other residues could be retained and worked up into superphosphates, dried blood and other fertilizers, and the minerals would find their way back to the land where they came from. As it is at present, the drain from the land each year, in the shape of ground-nuts exported to the coast, is very considerable.

On the subject of erosion the authors very rightly stress the need for urgent action. Soil erosion is evident everywhere to a greater or less degree, and is particularly severe in the Protectorate of Sierra Leone, where the burning of steep slopes for the cultivation of hill rice is causing a rapid loss of soil and the impoverishment of whole areas. In the Ibo country of south-east Nigeria erosion in its most spectacular form is seen, particularly in the Awka division. Here the soils are a light sand, and enormous chasms several hundred feet deep and miles long have been formed. These are extending rapidly and encroaching on the agricultural land, which is already overburdened with a heavy population. Many of these areas are already gone beyond hope of reclaiming, and the best that can be done is to proclaim them forest reserves and get them covered with some sort of tree growth as quickly as possible. The real problem is to prevent further erosion by tackling incipient gulleying at the source and preventing sheet erosion by contouring, strip cultivation and bunding in the fields that are in cultivation. The problem is an administrative one and needs a united drive on the part of the political officers and the local authorities with the technical advice of agricultural and forestry officers. The whole problem involves careful planning, and decisions have to be made with regard to the allocation of certain areas as forest reserves in order to protect the water sheds and to afford shelter belts. The latter are particularly important as a protection against wind erosion in the dryer areas of the north where top soil may be lost by 'blowing', but it is also important in the regions nearer the coast because indiscriminate felling of the forests allows the 'harmattan'—that intensely dry north wind from the Sahara—access to the cacao plantations which require a humid atmosphere for their proper development. Incidentally the belief, current in many quarters, that the fine sand blown by the harmattan is altogether deleterious is not quite correct. It is pointed out that it is not a sand, but is composed of alkaline clay far richer in plant foods than the soils on which it falls, and although only small amounts are deposited each year they are likely to do more good than harm.

It is impossible to refer in detail to the section on crop plants, which are described in some detail, but some reference must be made to cotton and cacao. The former crop is chiefly grown in the Zaria province in Northern Nigeria, and complaints have been made from time to time that the type of American Upland cotton now grown is weak in staple. It is suggested that other species of cotton such as *G. punctatum* or some of the old native cottons might be developed. Shortage of staff and war conditions have prevented action being taken on these lines. Meanwhile, it is worth noting that the Upland cotton, which is an annual crop, seems to produce good strong cotton up to the advent of the harmattan winds in January. When these winds set in the cotton plants suddenly dry up and wilt, and any cotton picked afterwards tends to ripen prematurely and to be very weak in staple. It would seem desirable, therefore, to gin and bale this later picking separately from the main crop, which is picked before the coming of the harmattan.

With regard to cacao, much has happened since this Report was written. It is a remarkable fact that cacao plantations all over the world are now suffering much damage from diseases and pests. The effect seems to become cumulative as the crop reaches about thirty years. During the last five years officers working in the Research Station at Tafo, which was opened in 1937, have discovered that much of the damage that was formerly ascribed to die-back or physiological trouble is in reality caused by a virus or a virus complex, one symptom of which is the 'swollen shoot'. These viruses, together with the attack of capsid bugs, is menacing the whole future of the cacao crop, which is the prop and stay of the Gold Coast. The cacao has shown signs of trouble for years past; but it is only as recently as 1937 that research was contemplated. Now that the danger is apparent, the step recently taken to convert the Tafo Station into a Central Cacao Research Station to serve the whole of West Africa is a great step forward. The Station can now hope to be adequately staffed and equipped, and continuity in the research work will be assured, which was not always the case under the former conditions.

The sections dealing with the types of West African agriculture give a most interesting and accurate account of the methods and will repay careful study.

As regards plantation agriculture, it is pointed out that the present systems of land tenure and Government policy tend to hinder European plantations in our West African Colonies, though this is not the case in adjoining French territories or in the Belgian Congo. So far as the production of crops for export is concerned the plantation system has undoubtedly many advantages over production by large numbers of small individual farmers. It must be remembered that most of these tropical export crops have to be processed in some form or another before they can be marketed. The plantation with its central factory and assured supply of raw material can do this more efficiently and turn out a better product than the small individual. Arrangements can also be made to plant only the best varieties and to effect improvements in planting methods. It is also in a better position to meet the demands of the markets as regards quality, grade and so on, and has a big advantage in the arrangements concerning transport and sale. It was for these reasons that the plantation products of the Far East were rapidly ousting similar products from the West Coast in the period before the War. It would seem necessary to realize that some sort of central organization will be essential in the future and methods need to be worked out whereby the plantations can be organized on a co-operative or collective basis. By this means crops would be raised by individuals retaining many of their old rights and growing their own food crops, but collected round a central factory which would do the processing and arrange for the marketing and transport. A suitable site for such an experiment would be in the British Cameroons. Here agriculture is already based on the plantation system and these plantations, which were formerly enemy property, are being managed temporarily by Government. The soils are extremely fertile and other conditions favourable, and the experiment would be well worth making.

The Report is in every way an informative one and is illustrated by a series of excellent photographs which give a good idea of the lives and occupations of the various races that live in the British West African Colonies.

EDUCATION IN PREVENTIVE MEDICINE

By SIR ARTHUR MACNALTY, K.C.B.

IN exploring a fresh field of knowledge in any subject, the pioneers have all the fun of the game. They devise their own methods and rules for investigation and try them out experimentally. It is necessary at length, when results have been achieved, to hand on the torch to others, and eventually an educational system, with professorial chairs, lecturers, text-books, demonstrations and the whole gamut of didactic instruction makes its appearance.

The preventability of disease had its ordered beginnings in the eighteenth and early part of the nineteenth centuries, and British practitioners of medicine took the lead of the world in this study. Richard Mead, in 1720, published his "Short Discourse concerning Pestilential Contagion and the Methods to be Used to Prevent it". John Pringle began hygienic reform for the British Army, and Dr. James Lind prevented scurvy and typhus. Other pioneers in preventive medicine were George Baker, Gilbert Blane, Edward Jenner and Turner Thackrah.

These men were all clinicians; they saw the consequences of disease, were not content with alleviating or curing maladies, but sought out their causes. In many cases they discovered that their patients' ill-health was due to bad environmental conditions—poverty, overcrowded dwellings, lack of fresh air and ventilation, filth, dirt and defective sanitation. Clinical medicine produced preventive medicine and constitutes its backbone. By a natural process of events, this new knowledge led to sanitary legislation, to a public health service and to systematic education in preventive medicine.

In an interesting inaugural lecture at the London School of Hygiene and Tropical Medicine, Prof. J. M. Mackintosh has traced the history of this education and foreshadowed its future trends.

It began in the year 1786 with Johann Peter Frank, who held the chair of clinical medicine in the University of Pavia and was appointed director of public health of Austrian Lombardy. In 1789 Andrew Duncan became professor of the Institutes of Medicine in Edinburgh and from 1795 gave weekly lectures on medical jurisprudence, devoting part of the course to the subject of "Medical Police", in which he dealt with both personal and environmental health, including hospitals and contagious diseases. In 1807 a university chair was created in these subjects with the stipend of £100 a year. At this time a number of British teachers were lecturing privately on hygiene, and books were written on the subject. John Roberton's treatise on "Medical Police" appeared in 1809, and in 1824 Gordon Smith defined the subject as "the application of medical knowledge to man in his social state"—no bad definition of social medicine. It was not until the year 1898 that the University of Edinburgh again had the distinction of instituting the first whole-time chair of public health.

The brilliant work of Sir John Simon and his colleagues at the Central Health Authority, and the appreciation of the work of those medical officers of health appointed by Liverpool, London and other progressive authorities, led to the obligatory general appointments of such officers by each local authority in 1872. By the Medical Act of 1886 (Section 21)

degrees and diplomas in public health were instituted. This opened the way for post-graduate teaching in public health to registered medical practitioners, and imposed on the General Medical Council the duty of controlling these qualifications and ensuring a proper standard of instruction. The first diploma was instituted by the University of Dublin in 1871, followed by Cambridge in 1875. Other universities and licensing bodies followed, and the Local Government Act of 1888 laid down that a registered degree or diploma in public health, sanitary science or State medicine was an essential qualification for a medical officer of health to a county or district of more than fifty thousand inhabitants. Regulations of the Ministry of Health now extend this requirement to all sanitary districts.

In the development of post-graduate study in public health, Prof. Mackintosh pays merited tributes to Sir Henry Acland, regius professor of medicine at Oxford from 1858 until 1894, Dr. William Stokes and Dr. Edmund Parkes.

H. W. Rumsey's essays on State medicine contributed much to education and practice. It is of interest to note that so early as 1856 he pointed out that the training and preparation of students for medical and sanitary employment was elsewhere acknowledged to be one of the most serious responsibilities of Government. He added: "It is one which no nation has ever neglected without loss to the State and injury to the people".

The seed thus sown has been long in fructifying, but we see some of its results in the University Grants Committee with its subsidies to medical schools, the foundation of schools with Government approbation and assistance, such as the London School of Hygiene and Tropical Medicine and the British Post-Graduate Medical School; and the recent report of the Royal College of Physicians with its suggestion that the cost of all medical education shall be defrayed by the State. Public opinion in Britain moves slowly. It is some ninety years since Rumsey wrote, and the nation is only beginning to realize its full responsibilities for the training and education of medical practitioners and post-graduates in its own vital interests.

The earliest examples of schools of preventive medicine in its broad and modern sense are the School of Hygiene and Public Health at Johns Hopkins University, the University of Toronto School of Hygiene and the London School of Hygiene and Tropical Medicine. All three schools drew much of their inspiration from a report prepared in 1915 by Dr. W. H. Welch and Mr. Wickliffe Rose and presented to the General Education Board of the Rockefeller Foundation. That Foundation in its wide generosity has promoted education in preventive medicine throughout the world and has made these three schools possible and successful. The first of them at Johns Hopkins University has admirably provided for research, intensive study and general instruction, and by its example has promoted the education and interest in preventive and social medicine throughout the United States. Gratitude is due in this respect to the labours of the late Dr. Welch, whose energy and enthusiasm was undiminished by the passage of years. In his planning of the School and its aims he had the advantage of the late Sir Arthur Newsholme's advice, and the latter's acceptance of the first lectureship in 1919 launched the new school under the best possible auspices. Equally the London School was fortunate in having at its helm such experts in preventive medicine as the late Sir Andrew Balfour and his successor, Sir Wilson Jameson.

In the beginning, organized preventive medicine concerned itself principally with environmental hygiene. The medical officer of health was regarded as a sanitary official chiefly occupied with administration and as having little concern with clinical medicine and the problems of disease, except in connexion with infectious fevers. Of late, preventive medicine has enlarged its activities by taking the individual in hand, by promoting facilities and education for keeping him healthy, and by preventing and treating disease in the individual in order to safeguard the community.

There was first the school medical service; then came the new health services for maternity and child welfare, tuberculosis and venereal diseases. The Local Government Act of 1929 placed many hospitals and other institutions under the control of the major health authorities, and the inter-war Housing Acts further increased the medical officer of health's responsibilities.

Prof. Mackintosh evidently realizes that there is much dead wood in public health education which might with advantage be cut away. This criticism applies both to undergraduate and postgraduate teaching. Too much detailed instruction is still given on sewage and refuse disposal and other problems of environmental hygiene concerning which the future medical officer of health only requires a general acquaintance, and the future general practitioner of medicine needs still less knowledge. The old syllabuses must be taken in hand and revised in the light of Prof. Mackintosh's counsel. Neither does it seem necessary for the public health student to spend so much time in the study of elaborate bacteriological technique and chemical methods of analysis.

Preventive medicine is not only changing but also advancing, and education in the subject must be adapted to the new discoveries and march of events. We see appreciation of the need for research and investigation in the recent founding of chairs of social medicine at Oxford and Birmingham. "In my view the primary aim of a School or University Department of Hygiene is to make good general practitioners in health, to send forth keen, competent men and women, with a high sense of their calling and a scientific outlook." Thus Prof. Mackintosh; and he goes on to emphasize the need in such a school for research in the basic sciences, the application of scientific work to the problems of public health, for example, through surveys, routine laboratory investigations, statistical and epidemiological studies and field experiment, the direct association with current health administration and direct teaching of the principles of preventive medicine. Furthermore, a school of preventive medicine must cater not only for the research student but also for the post-graduate student who desires to pursue intensive study in some special subject, such as statistics or biochemistry. If his bent is towards clinical subjects, for example, tuberculosis or pædiatrics, these are best studied elsewhere under a practising physician.

A course of preventive medicine must be largely academic and must be supplemented afterwards by the holding of clinical appointments to enable the intending medical officer of health to acquire the requisite experience for administrative posts, and to be in a position to appreciate and advise upon the

medical problems which will come before him. Let him beware of sticking too closely to his desk. He must visit clinics and hospitals to refresh his knowledge, be in sympathetic and friendly touch with his medical colleagues, play the man and not the bureaucrat.

These are revolutionary and epoch-making times. Great discoveries are being made in laboratories and hospitals which call for practical application in the prevention of human and social ills. It says much for the promise of the future that, in the midst of a world war, men of vision are able to find time to reflect, as Prof. Mackintosh has done, on the high ideals and humanitarian aims of teaching and practice in preventive medicine, and to plan for the years to come.

OBITUARIES

Sir Prafulla Chandra Rây, C.I.E.

BY the death on June 16 of Sir Prafulla Chandra Rây at the ripe age of eighty-three, Indian chemistry has suffered a severe loss. By his own contributions to science, but especially by his personal influence, Sir Prafulla was, more than anyone else, responsible for the great development of scientific research in India during the past fifty years.

P. C. Rây, the son of a small land proprietor, was born on April 20, 1861, and after receiving his early education in a village school he entered the Presidency College, Calcutta, where, although an arts student, he came under the influence of Sir Alexander Pedler, then professor of chemistry in the College, and he thus acquired an interest in chemistry. After graduation he gained a Gilchrist scholarship and in 1882 he proceeded to Edinburgh, where he studied chemistry, physics, botany and zoology. Here, after taking his B.Sc. degree, he worked in Crum Brown's laboratory, for whom he expressed his great admiration and affection. Remaining in Edinburgh for six years, he obtained the degree of D.Sc.; and, on his return to Calcutta in 1888, he was appointed an assistant in the Department of Chemistry at the Presidency College, later succeeding Sir Alexander Pedler in the chair. This appointment he held with great distinction until 1916, when he retired at the age limit and was appointed the first Palit professor of chemistry in the University College of Science. Here he continued to work until 1937, when increasing age and a partial failure of his eyesight compelled him to retire.

Both at the Presidency College and at the University College of Science, Rây built up outstanding schools of research, and nearly all the present professors of chemistry in the Indian universities have worked in his laboratory. Sir Prafulla's great activity over so long a period is all the more remarkable since his health was always poor. He was unmarried and led a very simple life, at one time living in a small room adjacent to the laboratory at the University College of Science. He devoted most of his income to providing stipends for his research students.

Rây's own researches were concerned mainly with the chemistry of the nitrites, and his first notable contribution was his discovery in 1896 of mercurous nitrite. Contrary to the view held previously, he showed that the nitrites are not unstable substances, and in a long series of papers published mainly in the *Journal of the Chemical Society*, he recorded the preparation of ammonium nitrite, the alkylammonium nitrites and various other members of the series. Important as were these investigations, it was by the enthusiasm for research with which he inspired his students that he will best be remembered. He found a further outlet for his energies by founding the Bengal Chemical and Pharmaceutical Works, now one of the leading firms in the Indian chemical industry.

Rây was profoundly interested also in the history of chemistry, and his "History of Hindu Chemistry" will always be regarded as a classical contribution to this field of study. In his later years he devoted much attention to the social and economic problems of India, and in his book "The Life and Experiences of a Bengali Chemist", published in 1933, he gave some account of this side of his activities. Although at times a severe critic of British policy he had a great affection for Great Britain, which he frequently visited. His knowledge of English literature was remarkable, and his tastes catholic, ranging from Shakespeare and Milton to "Tom Jones". He served as a member of a number of Government committees, and his intimate knowledge of India proved of great value in the deliberations of the Indian Chemical Services Committee, of which the late Sir Jocelyn Thorpe was chairman.

Sir Prafulla's services to science did not pass unrecognized; he was made a C.I.E. in 1912 and knighted in 1929. He was a fellow of the Royal Asiatic Society of Bengal and of the National Institute of Sciences, the first president (1924–26) of the Indian Chemical Society and a past president of the Indian Science Congress. His passing will be deeply regretted, not only by his Indian students to whom he was a true *guru*, but also by his many friends in Great Britain.

J. L. SIMONSEN.

Prof. W. Biltz

ACCORDING to an announcement in the *Chemiker Zeitung* of January 12, Dr. Wilhelm Biltz, professor of inorganic chemistry and director of the Laboratories at the Technical High School, Hanover, died on November 13, 1943. Born at Berlin in 1877, Biltz had a long and successful career as a research chemist and became one of Germany's leading authorities on inorganic chemistry. His work covered a very wide field, for with a succession of collaborators he carried out investigations upon most of the chemical elements, in the course of which he prepared hundreds of new compounds, especially double halides and other double salts, and his work has helped to clarify knowledge of the chemistry of uranium, tungsten, molybdenum and, more recently, rhenium. In his earlier work he gave much attention to density and conductivity determinations of solutions, while later work led him into studies of affinity. This involved heating mixtures of an element and sulphur (or phosphorus, etc.) in varying proportions and submitting the products to X-ray and other methods of analysis (for example, tensimetric) to determine the formulæ of the sulphides, phosphides, etc.

In 1909 Biltz wrote "Laboratory Methods in Inorganic Chemistry", and was for many years joint editor of the *Zeitschrift für anorganische Chemie*, in which many of his papers appeared.

NEWS and VIEWS

British Electrical and Allied Industries Research Asscciation

Retirement of Mr. E. B. Wedmore, C.B.E.

WIDESPREAD regret will be felt throughout the electrical industry that, on account of ill-health, Mr. E. B. Wedmore will be relinquishing the directorship of the British Electrical and Allied Industries Research Association at the end of this year. Mr. Wedmore has been the guiding hand of the Association since its incorporation in 1921 from the Electrical Research Committee of 1918. The success the Association has met with has been due, in no small measure, to his personal efforts, which have always been typified by high administrative ability combined with a wide and thorough knowledge of scientific and practical engineering affairs. The work which has been done by the Association, under Mr. Wedmore's ægis, has embraced a particularly broad field, and in many of the most important branches he has himself been actively concerned. Prior to his association with the E.R.A., Mr. Wedmore's experience included the educational field and the electricity supply industry, and he was prominent as a switchgear designer in the manufacturing industry, being interested very largely in automatic protective systems. His book "Switchgear for Electric Power Control" was published in 1924. He is a member of Council of the Institution of Electrical Engineers, a fellow of the Institute of Physics and has been a notable participant in many national and international conferences and technical assemblies. He was awarded the C.B.E. in 1938.

Mr. Wedmore's non-professional activities reflect the breadth of his interests. He is very well known in bee-keeping circles, and his book, "A Manual of Beekeeping for the English-speaking People", first published in 1932, is regarded as a standard work; bee-keepers throughout the country have long been indebted to him for the great interest he has taken in both the practical and the theoretical sides of their craft. In his own quiet way Mr. Wedmore has done a considerable amount of research work on honey bees and has spent a large part of his spare time lecturing to bee-keepers' associations and doing similar work. He is a member of the Apis Club, and of the Back to the Land Club. For many years Mr. Wedmore has been interested in craniology as applied to character study and in practical aspects of the work of the probation courts. He has also been active in the development of the theory of colour and in the geometry of four dimensions. Mr. Wedmore will take with him the very sincere wishes for a speedy restoration to good health, and a happy retirement, of a large circle of friends in the electrical and associated industries, which include the staff of the Association and the members of the large number of committees through which the Association functions. From January 1 next, Dr. S. Whitehead will take up the duties of acting director of the Association, and from July 1 Mr. R. A. McMahon will become secretary of the Association.

Astronomy: the Distaff Side

ROBERT S. RICHARDSON has an article with the above title in Leaflet 181 of the Astronomical Society of the Pacific, which shows the important part played by women in the advancement of science. Madame Curie is cited first of all, but most of the examples are taken from astronomy. The writer recalls with amusement the bewildered expression of visitors to the Lick Observatory on some public nights, when, instead of being greeted by an elderly professor, as they expected, they were given a lecture by a young woman. Several examples of the valuable contributions of women to the advancement of astronomy are cited. Madame Jean André Lepaute assisted Clairaut and Lalande in the computations of the perturbations of Halley's Comet by Jupiter and Saturn, and as a result of the work Clairaut was able to announce that the comet would pass perihelion on April 13, 1759. It actually passed perihelion 32 days before the time set by Clairaut; but as Uranus and Neptune were unknown at the time no account was taken of perturbations by these planets. Among other women of distinction reference is made to Caroline Herschel, Lady Huggins and Maria Mitchell, who assisted her father until she was forty-seven with routine computations in connexion with Government surveys for latitude and longitude. She was then appointed professor of astronomy and director of the Observatory at Vassar College, a position which she held until her death. In more recent times we have Miss Annie J. Cannon, Miss Antonia C. Maury and Miss Henrietta S. Leavitt. Not only have women made astronomy their career; they have also acted as patronesses, and notable among these are Mrs. Henry Draper, Miss Helen Snow, Miss Catherine Wolfe Bruce, Mrs. Alexander F. Morrison. Although nearly as many women as men do postgraduate work in astronomy with quite as much success, yet the total number of women engaged in astronomical research is small, because most of them become astronomers' wives instead of astronomers.

U.S. Committee for Post-War Research for Army and Navy

A COMMITTEE on Post-War Research for the Armed Forces of the United States has been appointed. At the first meeting there were present Charles E. Wilson (*chairman*), vice-chairman of the U.S. War Production Board; Dr. F. B. Jewett, president of the National Academy of Sciences; Dr. J. C. Hunsaker, chairman of the National Advisory Committee for Aeronautics; Dr. K. T. Compton, president of the Massachusetts Institute of Technology; Dr. M. A. Tuve, Carnegie Institute of Technology; Major-General O. P. Echols, assistant chief of Air Staff; Major-General A. W. Waldron, General Staff Corps, chief of Requirements Section, Army Ground Forces; Brig.-General W. F. Tompkins, director of Special Planning Division, War Department General Staff; Colonel R. M. Osborne, Army Services Forces; Admiral E. L. Cochrane, chief of the Bureau of Aeronautics. Other members of the Committee are Brig.-General T. D. Weaver, director of Industrial Demobilisation of the Army Service Forces; Rear Admiral G. F. Hussey, jun., chief of the Bureau of Ordnance, and Rear Admiral D. O. Ramsey, chief of the Bureau of Aeronautics. The purpose of the Committee is to prepare a plan and organizational procedure which will ensure the continued interest of civilian scientific workers after the War, in scientific research for the U.S. Army and Navy.

Mosquitoes in Britain

THE British Mosquito Control Institute at Hayling Island, Hants, has recently issued at the price of 1*s.* a useful pamphlet entitled "The Morphology and Biology of *Culex molestus*: Observational Notes for Investigators". The object of this publication is to facilitate the investigation of cases in which mosquitoes are causing (or periodically cause) annoyance in dwelling-houses or other buildings, especially those in 'built-up' areas. From among thirty species of mosquito known in Britain, *Culex molestus* closely resembles our commonest mosquito, namely, *C. pipiens*, in many ways. It is, however, a fierce and persistent blood-sucker of man, whereas *Culex pipiens* rarely (if ever) bites human beings. The species *molestus* can lay eggs without having had a blood-meal, although the number of eggs laid is much reduced. It breeds at all times of the year, and mating, unlike that of almost all other mosquitoes, can occur in a very confined space. So far as is known it breeds chiefly in accumulations of water in dark or semi-dark warm situations, but a good deal more needs to be found out on this subject and many other features regarding its habits. So far, *Culex molestus* has only been recognized in London, Harwich and Hull, but it needs to be known whether it has a wider distribution in the country. Anyone willing to help in this investigation can receive a free copy of the pamphlet mentioned on application to the Director of the Institute, Mr. J. F. Marshall, whose temporary address is "Wayside", 47 London Road, Cheltenham.

Diets for Patients with Ulcers of the Stomach and Duodenum

THE Ministry of Food, in collaboration with the Ministry of Health, has prepared a twelve-page pamphlet of diets for patients with ulcers of the stomach and duodenum. This pamphlet, which is not intended for the general public, since the dieting of cases of the above type is a matter for expert supervision, is approved by the Food Rationing (Special Diets) Advisory Committee of the Medical Research Council and will, it is hoped, help general practitioners, and others professionally concerned with the feeding of such patients, to cope with difficulties of war-time food supplies. The pamphlet contains rules for feeding and planning diets, weekly menus and recipes for patients who have either recovered from the acute stage of peptic ulcer or from whom symptoms due to the ulcer have almost disappeared. In planning the menus, the aim has been to provide a reasonably varied diet based on the foods available under present conditions to these patients. Copies of the pamphlet may be obtained by those professionally concerned with the problem, on application to the Secretary (Public Relations Division), Ministry of Health, Whitehall, S.W.1.

Incidence of Scarlet Fever

ACCORDING to the *Weekly Epidemiological Record* of March 2, in recent years scarlet fever has ceased to be a disease of any great clinical importance, but its geographical distribution is extraordinary as it is very frequent in northern latitudes and practically unknown in the torrid zone. In the seventies of the nineteenth century, its fatality in northern Europe was more than 10 per cent, and in mortality it exceeded any other acute infection. Between 1875 and 1885 the mortality was halved; it was halved again between 1885 and 1900, and in the present century it has fallen below 1 per cent. Scarlet fever is endemic in all parts of the world in which it occurs, but shows wide variation in incidence from year to year. During the present War, the incidence of this disease has shown no relationship to the public nutrition or the state of military activity, as is shown by the fact that in Germany, which is the best nourished country on the Continent and presents the greatest military activity, the incidence of scarlet fever is excessively high, as it is also in Norway, Holland and Greece, where the nutrition is low. In England and Wales, where the nutrition is good, incidence of the disease fell below normal until 1941, since when it has shown a slight increase. In the United States the numbers are still falling. It is noteworthy that in no country where returns are available has there been any reported increase of severity.

Substitutes for Structural Material in South Africa

Mr. N. Stutterheim and Mr. J. Shaw, of the Investigation Section of the Building Control, South Africa, described some work carried out by the Section during the ten months of its existence at a meeting of the South African Society of Civil Engineers on March 15. They discussed particularly the investigation of substitutes for steel and timber for building purposes. The work is being carried out in the Civil Engineering Department, University of the Witwatersrand, under Prof. Bernard H. Knight, acting head of the Department. The most promising material examined, taking South African conditions of service and also the question of supplies into consideration, appears to be 'Sorel' cement with sawdust filler, reinforced with wood lathes. It can be sawn, nailed and screwed, and tends to expand and contract with varying moisture conditions much as timber does. Its chief economic recommendation is that it can be cast to any size or shape without the use of high temperature, high pressure or skilled labour. Some houses have been built in Johannesburg in which all timber has been replaced with 'Sorel' cement composition. A sawdust cement composition has also been developed by certain South African firms. Other research work carried out by the Investigation Section has been the testing of tiles and flooring materials; for testing the latter, a machine has been devised in the University of the Witwatersrand consisting of leather pads fed with crusher dust to simulate the abrasive effect of leather soles and dust.

Properties of Paracon

ACCORDING to an article by B. S. Biggs (*Bell Lab. Rec.*, 22, No. 7; March 1944), when the development of 'Paracon', a new synthetic rubber, was announced by the Bell Laboratories, its resistance to oil and heat and its low brittle point, lack of odour and fast curing cycle were emphasized. Not all these characteristics can be held at maximum values in every composition, but various combinations of them can be obtained by selecting the intermediate compounds used in manufacture. This follows because the 'Paracons', in contrast with most elastic compounds, comprise a group of compounds rather than a single one. Chemically, the 'Paracons' are chain esters of high molecular weight. Among the substances that may be used are sebacic and succinic acids and ethylene and propylene glycols. These chemicals are obtainable from agricultural, coal and petroleum

products. Some of them are manufactured in reasonably large quantities, but they are inadequate to produce the huge tonnage of rubber used in the United States. For this reason and also because of its characteristics, 'Paracon' will probably remain a speciality product. The article gives some of the properties and uses of the material.

Portugaliae Physica

A NEW Portuguese journal of physics, *Portugaliæ Physica*—the first of its kind in that country devoted entirely to physics—has been established and has published its first number. The four papers which it contains comprise a calculation of the matrix of electrostatic interaction and orbit-spin for d^2p with an application to the spectrum of Ti II, a mathematical discussion of a group of operators with suggested application to quantum theory, and two papers on β-ray spectra with reference to internal conversion. In one of these, A. Gibert finds some evidence in support of Stahel's view that the energy quantum can be shared by more than one electron. At a time when the study of pure science has been necessarily replaced for so many by sterner pursuits, it is pleasant to realize that there are still countries where it is growing and needs new mediums for publication. Correspondence relating to the journal should be sent to *Portugaliæ Physica*, Faculdade de Ciências, R. da Escola Politécnica, Lisboa-Portugal.

Libraries Board of South Australia

THE annual report of the Libraries Board of South Australia, covering the year July 1942–June 1943, refers to the opening on July 30, 1942, of new temporary accommodation for the country lending service, with a further great increase in the number of books issued, as well as to the rapid development of the research service. The latter is now receiving inquiries from every State in Australia for its lists of scientific and technical literature. Through the Scientific Liaison Bureau it is establishing relations between bodies carrying on similar work through the Commonwealth. The Board emphasizes the urgent need for building extension to cover the expansion of the research service, etc. During the year 4,615 books were added, making a total of 197,112 and in addition to 7,500 volumes in the Symon Library and 10,757 in the country lending service. The main library catalogue now contains about 541,648 cards.

Earthquakes during March 1944

DURING this month eleven strong earthquakes were registered by the seismographs at the observatory at Toledo (Spain). The strongest to be recorded occurred on March 9, when *iPz* registered at 22h. 23m. 24s. from an epicentre some 62·5° distant; the earthquake attained a maximum amplitude at Toledo of 330 μ at 22h. 47m. 00s. The shock finished recording at 1h. 00m. 00s. on March 10.

At Wellington, New Zealand, during the same month, three strong earthquakes were registered by the instruments. These occurred on March 10, 22 and 31. In addition, eleven local earthquakes were felt in New Zealand during the month. The areas where these were reported as felt were Takaka, Nelson (March 15), Taupo (three times on March 20), Puysegur Point (on March 26), and Milford Sound (on March 29).

The United States Coast and Geodetic Survey, in co-operation with Science Service and the Jesuit Seismological Association, has determined two more provisional epicentres during the month. The earthquakes occurred on March 22 and March 31. The former was recorded at both Toledo and Wellington, and the latter at Toledo. On March 22 the earthquake happened at 0h. 43·0m. G.M.T. and its epicentre, based on instrumental reports from eleven stations, was found to be at lat. 7° S., long. 126° E., which is in the Banda Sea. On March 31 the earthquake occurred at 20h. 34·8m. G.M.T., and on instrumental reports from Fordham, Philadelphia, St. Louis and San Juan the epicentre has been calculated to have been at lat. 3° S., long. 81° W., which is in Ecuador.

Announcements

PROF. PETER KAPITZA has been awarded the Order of Lenin on the occasion of his fiftieth birthday, in recognition of his outstanding scientific achievements in physics.

PROF. W. P. WYNNE, emeritus professor of chemistry in the University of Sheffield, and a fellow of the Royal Society since 1896, has been elected a fellow of the Imperial College of Science and Technology, which he entered as a student sixty-three years ago.

THE Minister of Food has appointed Mr. Angus McKenzie, teacher of bread-making at the Royal Technical College, Glasgow, as a travelling bread adviser for Scotland. Any baker wishing to avail himself of Mr. McKenzie's services should either write to the Director of Bread, Bryn Euryn, Colwyn Bay, or Mr. McKenzie at his home address, 206 Cambusnethan Street, Wishaw.

AT the annual degree congregation of the University of Birmingham, the honorary degree of D.Sc. was conferred on Ernest Ansley Watson in recognition of his distinguished contributions to electrical engineering and, in particular, of his work on magnetos and on electric lighting of mines. The honorary degree of M.D. was conferred on Dr. Harry Guy Dain, Chairman of Council of the British Medical Association. The honorary degree of Master of Surgery was conferred on William Warwick James, in recognition of his eminent work on maxillo-facial injuries.

IT has been decided to postpone the conference on "The Nutritional Role of the Micro-flora in the Alimentary Tract", which the English Group of the Nutrition Society was to have held on July 22, at the London School of Hygiene and Tropical Medicine, Keppel Street, W.C.1. An announcement concerning the revised arrangements will be made later.

THE Council of the Royal Society of Arts offers the following awards under the Thomas Gray Memorial Trust, the objects of which are "The Advancement of the Science of Navigation and the Scientific and Educational Interests of the British Mercantile Marine": a prize of £50 to any person of British or allied nationality for an invention, publication, diagram, etc., during the period January 1, 1939–December 31, 1944, which is likely to be of value in navigation; an award of £50 for a deed of professional merit by a member of the British Merchant Navy during the year ending September 30, 1944. Claims in connexion with both awards must reach the Acting Secretary, Royal Society of Arts, John Adam Street, Adelphi, London, W.C.2, before December 31, 1944.

LETTERS TO THE EDITORS

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

Terrestrial Nemertines and Planarians in Britain

IN September 1943 I made a search for terrestrial planarians in the woods around the Yealm Estuary, South Devon. While doing so, a number of interesting organisms were brought to light.

(1) A terrestrial nemertine was found in the damper woods under fallen branches and later under stones and wood in damp situations in more open ground. It was commonly in company with the triclad *Rhynchodemus terrestris* and in places was numerous. It was found in widely separated places on both sides of the Estuary. The characters of this nemertine agree with those of *Geonemertes dendyi* Dakin.

The specimens were 5–15 mm. long and in general were of a yellowish colour with two brown longitudinal stripes on each side of the rhynchocoel. But the colour varied from almost white to orange, dark brown or even a purplish pink. The specimens possessed the arrangement of the eyes characteristic of the species, that is, two anterior groups of 4–6 eyes and two posterior groups of 3–5 eyes. The internal characters agree with those given by Hett[1] and Stammer[2]. Details of these will be published later. The only difference to be noted was in the number of proboscis nerves. Stammer gave the characteristic number of these as 14–15. Waterston and Quick[3] describe specimens with 13 proboscis nerves while my specimens commonly have 13 nerves, but sometimes 12 and in one case 11. In all the species of this genus, however, the number of proboscis nerves is variable, and in the two species closely related to *G. dendyi* their number is greater than 14. Of the many interesting anatomical features presented by these worms, the most outstanding is the nephridial system. The existence of this was mentioned by Stammer, but has not been described by him or by others. In my specimens the nephridial system shows the same peculiar characters as those in related species of the genus such as *G. hillii* Hett[4]. There are numerous small protonephridia immediately beneath the weakly muscular body wall. From each group of these a thin-walled duct leads to a long, coiled, glandular canal the cells of which have a very marked radial striation. This canal leads in turn to a duct opening to the exterior. These openings are very numerous. The glandular canals of my specimens are highly developed. They occupy well-defined lacunæ in the parenchyma and form conspicuous objects immediately beneath the muscle layer, particularly above and below the lateral nerve cords. The specimens that have been sectioned all proved to be females, but many were fertile and laid eggs which developed into young in about three weeks.

G. dendyi has been recorded three times. It was first described by Dakin[5] from a single specimen from Western Australia. Since in addition those species most closely related to it are confined to Australia, it is probable that the species is itself of Australian origin. Its subsequent history is remarkable. It was next found by Stammer in 1934 in greenhouses in Breslau. In 1937, it was recorded by Waterston and Quick in wild country near Swansea in Wales. It is now found apparently well established at places scattered round the Yealm Estuary in Devon. The possibility that it has been introduced into the northern hemisphere with some Western Australian plant suggests itself. An account of this organism will be published later.

(2) In company with *Rhynchodemus terrestris* were found at widely separated places round the Yealm Estuary a very few specimens of a Rhynchodemus clearly different from any recorded British species. It was some 6–10 mm. in length, of a brownish grey colour with two longitudinal purple brown stripes. Near the anterior end were two highly developed eyes with large lenses. The pointed snout is commonly carried a little upturned, giving the animal a somewhat ludicrous appearance of disdain. The organism is frail, and identification must await the collection of further specimens. In external characters, however, it agrees with Leidy's[6] description of the American species *Rhynchodemus sylvaticus* Leidy.

C. F. A. PANTIN.

Zoological Laboratory,
Downing Street,
Cambridge.
June 6.

[1] Hett, M. L., *Proc. Zool. Soc., Lond.*, 987 (1927).
[2] Stammer, H. J., *Zool. Anz.*, **106**, 305 (1934).
[3] Waterston, A. R., and Quick, H. E., *Proc. Roy. Soc. Edin.*, **57**, 379 (1937).
[4] Hett, M. L., *Proc. Zool. Soc., Lond.*, 775 (1924).
[5] Dakin, W. J., *Proc. Zool. Soc. Lond.*, 557 (1915).
[6] Leidy, J., *Proc. Acad. Philadelphia*, **5**, 289 (1851).

Birds and Butterflies

DURING a month's leave in the Anamalai Hills, Cochin State, South India, I have been studying the question of attacks by birds on butterflies. Both place and season (February–March) were well suited to such a study. The hills are covered by rain-forest, holding a rich fauna of insectivorous birds; and when I was there, shortly before the rains, some forty species of butterflies were on the wing, and some of these were common to abundance.

Take first the question of birds attacking butterflies in flight. Of insectivorous birds which take their insect-prey upon the wing, there were present: the large racquet-tailed drongo, bronzed drongo, wood shrike, paradise flycatcher (Tchitrea), several small flycatchers, broad-billed roller, chestnut-headed bee-eater (*M. leschenaulti*), spine-tailed swift, and the common Indian swift. I watched all these regularly, in the open glades, clearings and pathways which were the favourite haunts of butterflies; and I paid particular attention to the drongos, as being large, strong-flying birds, and a conspicuous feature in the jungle. *I did not see a single bird, of any species, catch or chase a butterfly.*

Two aspects of the question seem to me to have been all too little attended to. The first of these is the *time factor*. Jungle birds, like so many others, have their two main times of feeding and activity—early morning and late afternoon. While I was in the jungle, they started feeding about half-past seven and became idle about 10 a.m.; and then got to work again from about 4.30 p.m. until dusk. But the busy time for the butterflies was just the opposite; they were mostly on the wing in the middle of the day, from about 11 o'clock until four. Moreover, the butterflies seldom flew much higher than four

The vacancies advertised in these columns are available only to applicants to whom the Employment of Women (Control of Engagement) Orders, 1942-3, do not apply.

UNIVERSITY COLLEGE OF SWANSEA

(A constituent College of the University of Wales)

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

The twenty-fifth Session will open on Oct. 3, 1944.

Courses of study are provided for—

(*a*) Degrees of the University of Wales in Arts, in Pure Science, and in Applied Science (Metallurgy, Engineering, and Metallurgical Engineering);

(*b*) Diplomas of the College in Metallurgy and in Engineering;

(*c*) The training of teachers for elementary and secondary schools;

(*d*) The first medical examination of the University of Wales.

(*e*) The first year of the course for the degree of *Baccalaureus in Architectura*.

(*f*) The Preliminary Part of the scheme of study for the degree of *Baccalaureus in Pharmacia*.

College courses in Pure Science are recognized by a number of medical licensing bodies as constituting a first year of medical study.

Persons who are not desirous of studying for degrees or diplomas may attend selected classes, provided they satisfy the authorities of the College that they are qualified to benefit by such classes.

The College maintains a Hall of Residence for women students.

Entrance scholarships will be offered for competition in April, 1945.

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

EDWIN DREW,
Registrar.

Singleton Park,
Swansea.

UNIVERSITY COLLEGE OF SWANSEA

The Council invites applications for the following posts:

(i) ASSISTANT LECTURER in the Department of Mathematics. Salary £300 per annum. The appointment will date from October 2, 1944.

(ii) TEMPORARY ASSISTANT LECTURER in the Department of Physics for one year from October 2, 1944. Salary according to qualifications and experience, with a minimum of £300.

(iii) TEMPORARY ASSISTANT LECTURER in the Department of Engineering (with special qualifications in Electrical Engineering) for one year from October 2, 1944. Salary according to qualifications and experience, with a minimum of £300.

Further particulars may be obtained from the Registrar, University College, Singleton Park, Swansea, by whom applications must be received on or before August 5, 1944.

MERCHANT VENTURERS' TECHNICAL COLLEGE, BRISTOL

Applications are invited for appointment as full-time LECTURER in the SCIENCE DEPARTMENT of the above College. Principal subjects: Inorganic, Organic, and Physical Chemistry with subsidiary physics.

The work of the Department is mainly part-time technical, of Senior and Advanced Grades, for Ordinary and Higher National Certificate and A.R.I.C.

Candidates should be graduates capable of teaching up to Ordinary National Certificate standard at least. Opportunity for assisting with, and later taking responsibility for, more advanced work exists.

Salary, Burnham Technical Scale, plus war bonus. Incremental allowances for industrial and/or teaching experience. The post would suit a recent graduate who wishes to make a career in senior technical teaching.

Application form and particulars from the Registrar, Merchant Venturers' Technical College, Bristol.

ANDREW ROBERTSON, D.Sc., F.R.S.,
Principal.

Owing to enemy action advertiser is anxious for immediate purchase of laboratory bench and other chemical research equipment.—Box 213, T. G. Scott & Son, Ltd., 9 Arundel Street, London, W.C.2.

DEPARTMENT OF SCIENTIFIC AND INDUSTRIAL RESEARCH

Applications are invited for the post of SUPERINTENDENT of the ENGINEERING DIVISION of the NATIONAL PHYSICAL LABORATORY. Candidates should have considerable research experience in engineering and should also have a broad outlook on the possibilities of research applied to industry. The salary contemplated is up to £1,250, but the starting salary would depend on qualifications and experience. Superannuation provision will be made under the Federated Superannuation System for Universities. Applications, giving full particulars of qualifications and experience and not less than two personal references, should be sent to the Director, National Physical Laboratory, Teddington, Middlesex, not later than July 22, 1944.

SHEFFIELD RADIUM CENTRE

ASSISTANT PHYSICIST

Candidates are invited to apply for the post of Assistant Physicist to the Sheffield Radium Centre on an initial salary of £350 to £450, according to qualifications and experience, plus war bonus. F.S.S.N. in force. Should it be necessary, the successful candidate will be trained in the work peculiar to a Radium and Deep *X*-ray Treatment Department.

If found suitable he will, after some months, be transferred to the post of Physicist in charge of a Radium Centre at Nottingham on the Hospital Physicists' Association scale of £500—£25—£700, plus war bonus.

Applications, to be received not later than August 12, should be addressed to the Secretary, Sheffield Radium Centre, Royal Infirmary, Sheffield, 6.

THE HOME OFFICE FORENSIC SCIENCE LABORATORIES

Applications are invited for the post of BIOLOGIST at the West Midland Forensic Science Laboratory at Birmingham. Only well-qualified candidates of British birth and parentage should apply: a First Class Honours degree in Botany would be regarded as a special qualification. The salary would commence in the neighbourhood of £400, according to age and qualifications, with a possibility of extension up to £580: in addition, the department would pay the employer's contribution of 10% of the salary in respect of candidates insured under the Federated Superannuation Scheme for the Universities. Only a temporary appointment can be offered in wartime, but after the war the successful candidate would be considered for appointment to a permanent post on an incremental scale. Applications should be submitted on or before August 12, 1944, to the Establishment Officer (Room 320), Home Office, Whitehall, S.W.1, from whom further particulars may be obtained if required.

KING'S COLLEGE NEWCASTLE UPON TYNE

IN THE UNIVERSITY OF DURHAM

Applications are invited for the post of LECTURER IN MECHANICAL ENGINEERING. Duties to commence October 1, 1944. Salary from £500 per annum according to qualifications and experience.—Further particulars may be obtained from the undersigned to whom four copies of application, together with the names of not more than three persons to whom reference may be made, should be sent not later than Monday, July 24, 1944.

G. R. HANSON,
Registrar of King's College.

BEDFORD COLLEGE FOR WOMEN

(University of London)

The Council of Bedford College invites applications for the following post, open to men and women equally, vacant as from October 1, 1944:

DEMONSTRATOR in the Department of INORGANIC and PHYSICAL CHEMISTRY. Candidates must have an Honours Degree in Chemistry. Salary, £250 to £300 per annum plus war bonus.

Last date for receiving applications: Monday, July 17, 1944. For further particulars apply to the Secretary, Regents Park, N.W.1.

HERIOT-WATT COLLEGE, EDINBURGH

LECTURER IN CHEMISTRY DEPARTMENT

The Governors invite applications from British subjects for a Lectureship in Chemistry. Salary scale £300—£15—£500, plus war bonus. Candidates will be placed on scale according to qualifications and experience.

Applications must be made on forms to be obtained with full particulars from the College not later than July 24.

J. CAMERON SMAIL,
Principal.

STAFFORDSHIRE EDUCATION COMMITTEE

COUNTY TECHNICAL COLLEGE, STAFFORD

Applications are invited for the post of PRINCIPAL of the above College. Candidates should have graduate or equivalent qualifications, preferably in Engineering. Industrial and teaching experience essential. Commencing salary £750.

Form of application (returnable by July 17) and further particulars may be obtained from the undersigned.

F. A. HUGHES,
Clerk to the Governors.

County Education Offices,
Stafford.

UNIVERSITY OF READING

The Council invites applications for a LECTURESHIP IN CHEMISTRY. Candidates should possess special qualifications in Physical Chemistry. The initial salary will be not less than £400 per annum.—Further particulars may be obtained from the Registrar, with whom applications should be lodged not later than July 24.

Required: Lecturer in Physiology at Nonington College of Physical Education. The successful candidate will be expected to take full charge of Theory and Practical Classes of a two years' course preparing students for the London University Diploma in Physical Education. (Newly equipped Laboratory available.) Recent Science Graduate may apply. Full or part-time appointment.—Apply, Principal, Nonington College, Bromsgrove.

University of London. The Senate invite applications for the CHAIR OF MATHEMATICS tenable at Royal Holloway College (salary not less than £1,000).—Applications must be received not later than first post July 26, 1944, by the Academic Registrar, University of London, c/o Richmond College, Richmond, Surrey, from whom further particulars should be obtained.

Organic Research Chemist permanently required by Company for pure organic research work on chemotherapeutic problems. (E.W.O.). Good salary and prospects of future advancement.—Apply, with details of career and publications, to Box 212, T. G. Scott & Son, Ltd., 9 Arundel Street, London, W.C.2.

Dietitian required for Nutrition Department of large Industrial Caterers.—Please apply, with full particulars, to Box 211, T. G. Scott & Son, Ltd., 9 Arundel Street, London, W.C.2.

Export: Managing Director established New Zealand distributors, visiting England shortly, desires contact Manufacturers binoculars and Cameras and Associated lines. Buying Agencies required now. Substantial orders can be placed immediately manufacturing facilities available.—Write Sawell, 4 Ludgate Circus, London, E.C.4. Central 4353.

Translations of Scientific and Technical Papers from Danish, Dutch, French, German, Italian, Norwegian, Russian, Spanish and Swedish originals. Thirty-five years experience.—George Borrow, 6 St. Stephen's Grove, London, S.E.13.

Microscopes, of all descriptions, only a few available second-hand, perfect condition. Send details of your requirements enclosing 3d. stamp.—Chards, Microscope Specialists, Forest Hill, S.E.23.

PRINTED IN GREAT BRITAIN BY FISHER, KNIGHT AND CO., LTD., ST. ALBANS

or five yards from the ground; while most of the insectivorous birds, especially the drongos, bee-eaters, rollers and swifts, feed twenty feet up at the least. There may be no hard and fast line here, but there is a clear and general tendency.

It was in these same hills that Mr. Salim Ali recorded[1] a huge hatch of "thousands upon thousands" of the large butterfly *Danais melissa dravidarum*, which were being taken on the wing by the ashy swallow shrike (*Artamus fuscus*). This bird I did not see. But Mr. Salim Ali notes that "*they were the only bird-species interested in these butterflies*", and concludes, from his observations elsewhere, that their food "seems to consist of butterflies to a very large extent".

Attacks by birds on butterflies not flying but at rest is the second part of my subject; and I found a good many more birds taking their insect-prey from trees and undergrowth than hawking it on the wing. Swifts, rollers and bee-eaters took no insects at rest, only those on the wing; all the others mentioned above took them at rest, and so did the other insect-eating birds, such as the babblers, warblers, white-eyes (Zosterops) and orange minivets; while bulbuls, mynahs and tree magpies were all partially insectivorous. It is not so easy to watch the feeding-habits of these birds as of those which take their prey upon the wing; but once again, my results were all completely negative—these birds ate no butterflies at all.

As to the ecological side of the question, most of the butterflies go to rest within small clumps of bamboo and other undergrowth, or occasionally in the inner foliage of evergreen trees. But only a few birds made these their usual feeding-places, such as the warblers and the white-eyes, both small birds with weak bills, and the babblers which are strong active birds; these latter roam the forest in bands or companies, and habitually search the dense thick undergrowth, the resting habitat of many butterflies. Thus the babblers would seem to be by far the most likely predators on butterflies (in addition to Artamus) in this region. But though I caught a number of butterflies, and paid particular attention to those with tattered wings, in no single case could I detect a trace of beak-marks on their wings.

C. R. STONOR.

South India.

[1] *J. Bombay N.H.Soc.*, **38**, 315 (1935).

Production of Mutations by Allyl *Iso*thiocyanate

IN the course of the past few years, we have examined a number of chemical substances for their ability to produce gene mutations. The experiments were carried out on *Drosophila melanogaster*. Some of the substances were found to be highly effective, producing mutation-rates of the same order as those obtained with X-rays, 6–24 per cent sex-linked lethals developing in treated *X*-chromosomes. These data will be published later.

Although the production of mutations by these potent synthetic substances is of great interest for the light it may throw on the nature of the gene and the process of mutation, the search for naturally occurring substances with the capacity to produce the same effect appears, from the point of view of evolutionary theory, even more important. It is therefore of special interest that among the substances tested we have found one, namely, allyl *iso*thiocyanate (mustard oil), which has a definite though slight effect on the mutation-rate, and which occurs naturally in a variety of plants, for example, *Brassica nigra* and other Cruciferæ (Klein[1]). A summary of the data on which this conclusion is based is given below. A full report will appear later.

The technique used was the *ClB* test for sex-linked lethals, which is the standard test used for detecting lethal mutations which develop in the *X*-chromosomes of the spermatozoa in treated (and control) males. Two experiments were carried out. With the second a control was done simultaneously on flies collected from the same culture bottles as the flies for treatment. The results are shown in the accompanying table.

Expt.	No. of *X*-chromosomes tested	No. of lethals detected in the chromosomes	Lethals (per cent)
1	756	17 (+1 doubtful)	2·2
2	878	19	2·2 } Diff. = 15±4·8
Control	963	4	0·4 }

The difference between the treated and control series in the second experiment is clearly significant. Moreover, in both experiments the mutation-rate markedly exceeds the range of the spontaneous occurrence of sex-linked lethals in normal stocks, which scarcely ever reaches even 1 per cent.

In addition, three sex-linked visible mutations were obtained in the two treated series, none in the controls.

Experiments are under way to determine whether allyl *iso*thiocyanate can also produce chromosome breaks.

C. AUERBACH.
J. M. ROBSON.

Institute of Animal Genetics
and Department of Pharmacology,
University of Edinburgh.
June 5.

[1] Klein, G., "Handbuch der Pflanzenanalyse", Part 2, Chapter 26 (Springer, Vienna, 1932).

Increased Alkaloidal Contents of Induced Polyploids of Datura

TETRAPLOID plants of various species of Atropa, Datura and Hyoscyamus have been produced by the treatment of their seeds with colchicine solution; polyploidy being judged by the sizes of stomata or of pollen grains and by chromosome counts in root-tip preparations. Tetraploid plants of *Datura Stramonium* Linn. and *D. tatula* Linn. were healthy in appearance and produced as great a weight of dry leaf per plant as the diploid controls. Abundant viable seed was collected from them and produced F_1 and F_2 generations of tetraploids in the two following years.

Chemical determinations of the individual alkaloids *l*-hyoscyamine, atropine and hyoscine have been carried out on the dried leaves from diploid and tetraploid plants grown from seed of different origins. Results of assays, calculated with reference to the leaves dried at 100° C. for six hours, are shown in the accompanying table.

Analyses of F_1 and F_2 generations showed similar

Seed stock	Diploid controls				Tetraploid plants			
	Total alkaloid per cent	Percentage ratio of total alkaloid			Total alkaloid per cent	Percentage ratio of total alkaloid		
		Hyoscyamine	Atropine	Hyoscine		Hyoscyamine	Atropine	Hyoscine
Datura Stramonium								
A	0·20	81	5	14	0·55	82	6	12
B	0·35	68	18	14	0·50	78	8	14
C	0·27	76	8	16	0·50	75	12	13
Datura tatula								
A	0·24	83	nil	17	0·40	85	nil	15

alkaloidal contents to those of the parental tetraploid plants. The provisional conclusion may thus be drawn that the percentage total alkaloidal contents of tetraploid plants of *D. Stramonium* and *D. tatula* are approximately double those of the diploid plants; while the proportions of the individual alkaloids present remain unchanged.

Assays of tetraploid and diploid material from other species of Datura and from species of Atropa and Hyoscyamus are not yet completed. It is hoped to publish a detailed account of these researches when the results of the 1944 growing season have been obtained.

J. M. ROWSON.

Depts. of Botany and of Pharmacy,
University, Manchester.
June 19.

Relation of the Concentration of Vitamin A, Carotenoids and Cholesterol in Milk Fat to the Size of the Fat Globules

SOME time ago, Henry *et al.*[1], in measuring the vitamin A and carotene content of samples of fat churned or extracted by solvents from the same batch of milk, found that the concentration of vitamin A was the same in the fats prepared by both methods, but that there was slightly more carotene in the extracted fat. This they attributed to destruction during churning.

We have now obtained substantial evidence to show that this explanation is not correct, and that the small difference was due to the relatively high concentration of carotenoids in that fraction of the original milk fat which remained in the separated milk. We have carried out several experiments in which vitamin A and carotenoids were measured at the different stages of butter-making. In some of these experiments cheese was also prepared from the same bulk of milk and similar measurements were made on the whey, and at the different stages of butter-making from whey. Samples obtained during the separation by gravity of cream from milk were also examined. The results quoted in the accompanying table may be taken as an example. It shows that although the vitamin A was substantially the same in all fractions, the fat of separated milk contained seven times and the fat of separated whey eleven times as much carotenoids as the original milk fat. These two fractions consisted of the smallest fat globules which were not removed by two centrifugings in a dairy separator. The concentration of carotenoids in the fat of buttermilk and in the fat of whey was also higher than in the original milk, though the difference was very much less marked. Measurements showed that the size of the fat globules of these fractions was intermediate between that of the globules of the original milk and that of the separated milk. It will be seen that a very close correlation exists between the amounts of carotenoids and of cholesterol in the various fat fractions. Our values for cholesterol are of the same order as those reported by Frengley and Herrick[3] and by Ansbacher and Supplee[4] in similar fractionation experiments. Iodine values of the fatty acids prepared from the fats varied little, but were somewhat higher in the fats from separated milk and separated whey.

The difference in behaviour between vitamin A and carotenoids is very striking. The uniform concentration in which the former occurs in the different fat fractions suggests that it may be in true solution in the fat. The carotenoids and cholesterol, on the other hand, are present in greater amounts in those fractions in which the ratio of fat globule surface to fat is higher, and therefore may be associated in some way with the fat globule membrane.

Further work on these problems is in progress.

Fraction	Method of extraction of fat	Fat (gm. per 100 ml.)	Vitamin A (I.U. per gm. fat)	Carotenoids (μgm. per gm. fat)**	Cholesterol (mgm. per gm. fat)	Iodine value of fatty acids	Average radius of fat globules (mean of 200 measurements)
Milk	Solvent*	3·14	24·7	9·8	3·3	38·5	1·41
Cream	Solvent*	35·35	25·3	9·5	2·8	41·5	1·68
Separated milk	Solvent*	0·06	21·6	65·4	36·0	45·2	0·51‡
Butter	Churning	86·90†	26·3	9·4	2·5	40·2	—
Buttermilk	Solvent*	1·98	24·2	12·2	6·0	42·3	0·89
Whey	Solvent*	0·42	23·2	14·9	5·6	37·8	1·09
Whey cream	Solvent*	18·20	24·7	9·4	3·3	40·2	1·80
Separated whey	Solvent*	0·03	26·2	111·0	46·0	48·0	§
Whey butter	Churning	83·90†	26·3	9·3	2·7	40·1	—
Whey buttermilk	Solvent*	2·25	23·9	12·4	5·3	42·0	0·84

* The method was that of Olson *et al.*[2] slightly modified.

† gm. per 100 gm.

** The percentage of β carotene measured by chromatography did not vary greatly in the different fat fractions; the range was 74–83 per cent.

‡ Only 50 globules measured.

§ Owing to small size and scarcity of the fat globules, satisfactory measurement was not possible.

S. K. KON.
E. H. MAWSON.
S. Y. THOMPSON.

National Institute for Research in Dairying,
University of Reading.
June 19.

[1] Henry, K. M., Kon, S. K., Gillam, A. E., and White, P., *J. Dairy Res.*, **10**, 114 (1939).

[2] Olson, F. R., Hegsted, D. M., and Peterson, W. H., *J. Dairy Sci.*, **22**, 63 (1939).

[3] Frengley, M. G., and Herrick, M. M., *Bull. N.Z. Dept. Sci. Indust. Res.*, No. 34 (1931).

[4] Ansbacher, S., and Supplee, G. C., *J. Biol. Chem.*, **105**, 391 (1934).

Production of Penicillin

THE usual method adopted in the large-scale production of penicillin is to grow *Penicillium notatum* on shallow layers of modified Czapek-Dox media[1] at 24°C. for 10–12 days. The metabolic solution at the end of the incubation period has an activity of 3–4 'Oxford' units per c.c. This process involves handling large volumes of solution, and the space required is enormous. Moreover, the danger of contamination by penicillin-destroying bacteria during the lengthy incubation period is obvious.

Various attempts to shorten the incubation period and increase the yield of penicillin have been made; the more important ones are by Clifton[2] and by Srinivasa Rao and De[3]. The first one suffers from the difficulty of bacterial contamination. The second method using semi-solid media has been developed further in our laboratories.

Among the various semi-solid media tried by us, the best so far was found to be wheat bran. It provides the necessary loose physical structure facilitating aeration and also provides a large surface for growth of the mould. Maximum anti-*Staphylococcus aureus* activity was reached after 48 hours incubation. Addition of nutrients like yeast extract, etc., did not increase the yield of penicillin or shorten the incubation period. The procedure is briefly as follows:

30 gm. of wheat bran (particles of large size are preferable) are weighed out into 750 c.c. conical flasks, moistened with equal weight of water and mixed well. The flasks are plugged and autoclaved at 15 lb. pressure for one hour. The sterilized flasks are then inoculated with about 1 c.c. of a spore suspension of *Penicillium notatum*, well shaken and incubated at 24° C. for two days. The flasks are shaken once after 24 hours. This procedure gave consistently penicillin activity of 30 'Oxford' units per gram with Fleming's strain (N.C.T.C. No. 4222) tested by serial dilution method against *Staphylococcus aureus* Oxford. Another strain of *Penicillium notatum* has given us an activity of 150 units per gram.

The advantages claimed for the above process apart from low cost of manufacture are: (1) ease of handling semi-solid media; (2) consistent yields; (3) growth-time is reduced to two days, which is equivalent to increasing yield by five or six times; (4) the water extract of mouldy bran can be concentrated by using it for re-extraction with fresh mouldy bran to a fairly high potency; (5) bacterial destruction of penicillin is avoided; (6) large-scale methods used in the manufacture of taka-diastase can be used.

The concentrated crude extract is being used for local application to surface wounds with very good results.

My thanks are due to Drs. S. P. De and N. H. De for kind assistance and to Prof. V. Subrahmanyan for his keen interest in the work.

S. SRINIVASA RAO.

Department of Biochemistry,
Indian Institute of Science,
Bangalore.
April 6.

[1] Abraham, Chain, *et al.*, *Lancet*, **241**, 177 (1941).
[2] Clifton, C. E., *Science*, **98**, 70 (1943).
[3] Srinivasa Rao, S., and De, S. P., *Cur. Sci.*, **12**, 209 (1943).

Production of Ovulation by Fluoride *in vitro*

IN the course of an investigation on the action of enzyme inhibitors on pituitary-induced ovulation of the frog's ovary (*Rana pipiens*) *in vitro*, it was found that sodium fluoride would potentiate the pituitary effect. This unexpected result was considered as possibly associated with the binding of calcium by fluoride. Accordingly, the effect of other experimental procedures such as the use of calcium-free Ringer, oxalate, change in *p*H, etc., was investigated. A summary of the results together with probability values is shown in the accompanying table.

Agent	Molar conc.	Pairs of ovaries	No. eggs extruded		Value of *P*
			Treated	Control	
Sodium fluoride with pituitary	10^{-2}	4	2159	634	< 0.01
Sodium fluoride without pituitary in calcium-free Ringer	10^{-2}	16	1699	1	< 0.01
Sodium oxalate	10^{-2}	12	3630	3974	< 0.05
Calcium-free Ringer	—	8	1822	1031	0·05–0·01
Ringer *p*H 5·6 (treated) and *p*H 7·4 (control)	—	8	672	2593	< 0.01
Sodium iodoacetate	10^{-3}	4	0	1766	0·05
Sodium iodoacetate	9×10^{-5}	4	395	1366	0·05—0·01

The procedures were similar to those previously reported[1]. Unless otherwise specified, the ovaries were removed and suspended in a total volume of 30 c.c. of buffered Ringer (*p*H 7·4) containing female frog pituitary together with the agent to be tested. Ovaries were studied in pairs, the left ovary serving as control for the right and vice versa. The total number of pituitary glands for the experiment was removed, finely macerated in 1–2 c.c. of distilled water, and taken up in a large volume of Ringer. The equivalent of two pituitary glands was then pipeted into a Petri dish into which one ovary was placed. Each experiment was allowed to run 31 hours, at the end of which time the ovaries were washed and the extruded eggs counted.

It is apparent (see table) that sodium fluoride potentiates the effect of pituitary in inducing ovulation and will, moreover, by itself cause egg release.

Fluoride may be considered to exert its action either through (1) a binding of calcium, or (2) an inhibition of some portion of the respiratory or glycolytic mechanisms. Chambers[2] found that calcium is necessary for the stability of the intercellular cement of capillaries and kidney tubules; and when the calcium of the cement substance is decreased by using calcium-free solutions or lowering the *p*H, it becomes loosened. Loosening of the intercellular cement could be expected to favour ovulation by permitting a more ready rupture of the cell layers surrounding the egg. While the results with fluoride and calcium-free Ringer might be interpreted on this basis, the oxalate and *p*H experiments apparently do not support such a view.

With respect to the action of fluoride on glycolysis, one may postulate that the accumulation or deficiency of a particular intermediate substance or substances initiates processes which result in ovulation. The relatively high concentration of fluoride (10^{-2} *M*) may well inhibit respiration as well as glycolysis. Inhibition

of the glycolytic mechanism as a whole, however, does not satisfactorily explain the fluoride effect, inasmuch as iodoacetate, which produces the opposite effect to fluoride on ovulation, also inhibits glycolysis[3]. Oxalate, which is without significant effect on ovulation, may also inhibit glycolysis under certain conditions, but is without effect on living yeast, presumably because of its failure to penetrate[4].

We have been obliged to discontinue these experiments temporarily owing to the advent of the season of spontaneous ovulation in our frogs.

Grants in aid of this work received from Eli Lilly and Co. and the National Research Council of Canada are gratefully acknowledged.

K. M. WILBUR.
M. K. MCPHAIL.

Depts. of Physiology and Pharmacology,
Dalhousie University,
Halifax, N.S.
May 22.

[1] McPhail, M. K., and Wilbur, K. M., *J. Pharmacol. and Exp. Therap.*, **78**, 304 (1943).
[2] Chambers, R., Cold Spring Harbor Sympos., **8**, 144 (1940).
[3] See chapter by Cohen, P. P., "Respiratory Enzymes" (Minneapolis, 1939).
[4] Runnström, J., and Hemberg, T., *Naturwiss.*, **25**, 74 (1937).

Treatment of Blackwater Fever

HÆMOLYTIC substances were demonstrated in the peripheral blood of three patients. They appear a few minutes before an attack of hæmoglobinæmia and are rapidly removed from the serum by the red blood cells. The hæmolytic properties of the serum can be preserved if the red blood cells are rapidly removed by centrifuging[1].

The hæmolytic process is accentuated by quinine (1 in 300), pamaquine (1 in 1,000) and mepacrine (1 in 500) and antagonized by antivenine (1 in 300); antivenine also antagonizes the action of drugs.

The clinical use of antivenine has been attended with complete success. 200 ml. initially, followed by 10 ml. at intervals of four hours, completely cut short an attack of blackwater fever in thirty-six cases, in which the mortality ordinarily would have been 25–50 per cent. Furthermore, in three cases, the administration of mepacrine in full doses together with antivenine cured the blackwater fever together with the causative malignant malaria.

INDER SINGH.
INDERJIT SINGH.

Brigade Laboratory,
Allahabad.

[1] Singh, I., and Singh, I., *Ind. Med. Gaz.* (in the Press).

Structure of Cellulose

IN a recent communication[1], Peirce has put forward considerations on the structure of cellulose based on a pyranose ring in which the five carbon atoms are nearly co-planar and there is a right angle between the bonds of the ring oxygen. We should like to say that to invoke such a configuration is unnecessary and unjustified by the evidence. To be sure, a flat or flattish ring was long current in the X-ray literature on cellulose[2], but it was never easy to see the real need for it, and latterly Meyer and Misch[3] have stated that the X-ray intensities support the 'armchair' ring equally well and have gone over to that form.

Contrary to what Peirce suggests, the *trans-*, or armchair, form of the Sachse strainless ring does give the observed fibre period of cellulose very closely ($10{\cdot}3_7$ A. as compared with $10{\cdot}3_0$ A.), if one takes 1·54 A. for the length of the C–C bond and 1·42 A. for the C–O bond, with the tetrahedral angle for the carbon inter-bond angle and 110° for the oxygen inter-bond angle[4]. Our own immediate interest in the matter arises from an X-ray study of the structure of alginic acid and its relation to that of cellulose and its derivatives. To reproduce quite accurately the characteristic dimensional features of these two different chain configurations (and probably of pectin also), we have not yet found any necessity either for going outside such concepts of sugar chemistry as have been built up particularly by Haworth, Hirst and their collaborators, or for departing seriously from accepted bond-lengths and angles derived from simpler compounds; and full-scale models, also, that we have constructed of regenerated cellulose are satisfactory in these respects.

In support of his proposals, Peirce cites the earlier work of Cox and his collaborators: their later work, however, goes far to establish the strainless armchair ring. Cox and Jeffrey on glucosamine hydrobromide[5], for example, go almost all the way; but perhaps the most convincing evidence is found in an X-ray investigation by Cox and Brown[6] of the crystal structure of β-methyl xyloside. Here a three-dimensional Patterson synthesis reveals only three vectors of length approximately 1·5 A., and there is only one form of the xyloside molecule that is compatible with such a result, namely, the strainless armchair. The same shape of molecule provides also what appears to be a unique explanation of the observed intensities of reflexion from the $(30\bar{4})$ and (402) planes.

W. T. ASTBURY.
M. M. DAVIES.

Textile Physics Laboratory,
University of Leeds.
June 7.

[1] Peirce, F. T., *Nature*, **153**, 586 (1944).
[2] For example, Meyer and Mark, "Der Aufbau der hochpolymeren organischen Naturstoffe" (1930).
[3] Meyer, K. H., and Misch, L., *Helv. Chem. Acta*, **20**, 232 (1937).
[4] Pauling, "The Nature of the Chemical Bond" (1939).
[5] Cox, E. G., and Jeffrey, G. A., *Nature*, **143**, 894 (1939).
[6] Brown, C. J., Ph.D. thesis, University of Birmingham (1939).

IT is not stated whether the new structure for cellulose proposed by Dr. F. T. Peirce[1] is in better agreement with the X-ray intensities than those previously put forward; but as some justification for it is sought in the earlier work of the Birmingham school, the following observations may be relevant. These observations are of a somewhat general character as the records of my unpublished work are not at present at hand.

At the time the paper[2] quoted by Peirce was written, X-ray technique was insufficiently advanced for detailed analyses of individual saccharides to be made, and the views advanced as to the conformation of the pyranose ring were based on a general survey of a large number of compounds. In the light of more recent work, it seems probable that as the molecular arrangement in polyhydroxy compounds is determined largely by the distribution of OH groups, whereas that in methylated sugars depends chiefly on general molecular shape, deductions from a survey covering both types are not so con-

elusive as they appeared in 1935. Later work (for example, ref. 3, but chiefly unpublished) has included very detailed analyses in which atomic positions have been fixed to rather better than 0·1 A., and within this limit there is no evidence that the pyranose ring departs from the Sachse *trans* conformation; this is not to say that I believe that small deviations from exactly tetrahedral bond angles are necessarily excluded or indeed improbable, but since the possible combinations of deviations are so numerous, it would seem to be advisable to restrict speculations on the structure of cellulose to tetrahedral configurations until experimental evidence requires some departure from them.

While I believe that the structure of cellulose will best be determined, as suggested by Peirce, by combining the knowledge of atomic arrangements found in crystalline oligosaccharides with the less detailed information obtained from cellulose itself, it must be emphasized that the assignment of atomic parameters in cellulose with an accuracy of 0·01 A. is at present entirely speculative[4], since the most detailed saccharide crystal analysis so far reported[3] gives atomic positions only to about 0·08 A., and the data from cellulose itself certainly do not justify any higher accuracy.

E. G. Cox.

The Frythe,
Welwyn,
Herts.

[1] *Nature*, **153**, 586 (1944).
[2] Cox, Goodwin and Wagstaff, *J. Chem. Soc.*, 1495 (1935).
[3] Cox and Jeffrey, *Nature*, **143**, 894 (1939).
[4] Cf. Cox, *Ann. Rep. Chem. Soc.*, **34**, 194 (1937).

Thermodynamics of Friedel-Crafts Reactions

SINCE the time of Gustavson[1] and Menschutkin[2] it has been known that salts of the $AlCl_3$ type can give stable complex compounds with certain classes of organic compound.

We have measured the heats of formation from the salt plus organic liquid of a number of these complexes. A Dewar-vessel calorimeter was used, and the results were corrected for spurious heat effects, such as those arising from chemical reactions other than complex formation. In some cases the heats are surprisingly large, and, neglecting entropy effects, it has seemed reasonable to us to ascribe an important role in these cases to the complex-formation stage, in controlling the course and products of the reaction.

For example, consider the two reactions below

$$CO_g + C_6H_6l = C_6H_5CHOl \text{ . catalysed by 1 mole of } AlBr_3 \quad (1)$$

$$nCH_3Cl_g + C_6H_6l = C_6H_{6-n}(CH_3)_nl + nHCl \text{ catalysed by a small amount of } AlCl_3 \quad (2)$$

Calculation from heat of combustion and entropy data yields values of ΔG° for both reactions in the neighbourhood of zero (restricting ourselves to the case $n = 1$, 2 and 3 in reaction 2). There is an uncertainty in the heats of combustion which gives an error of perhaps $\pm$ 1 kcal. in case 1, and a possibly larger error in reaction 2, due to the uncertain data for CH_3Cl_g. This uncertainty is not likely to affect the point we wish to make.

In both cases no stable complex is formed between the catalyst and the reactants, and we are concerned with the products only. Considering reaction 1, we have found that the heat of formation of the complex $AlBr_3(C_6H_5CHO)_x$ is 30 kcal. per mole of aluminium bromide. It therefore seems reasonable to suggest that this complex-formation, by making the overall free energy of reaction strongly negative, plays a large part in ensuring the excellent yields normally obtainable in this reaction[3].

Our calculation for reaction 2 would suggest that, complex formation apart, none of the possible products toluene, xylenes, trimethylbenzenes should be specially favoured on thermodynamic grounds. This view is supported by the observations of Boedtker and Halse[4], on the reversibility of this reaction, carried out under normal liquid-phase conditions. However, we find that the heats of complex formation are $AlCl_3$/xylene 22 kcal.; $AlCl_3$/mesitylene 8 kcal.; and $AlCl_3$/toluene 0 kcal. Clearly, we should expect the preferential formation of the $AlCl_3$/xylene complex, and this in fact may be found under special conditions. If methyl chloride gas is passed over aluminium chloride in a vertical catalyst tube, xylene is preferentially obtained as the $AlCl_3$/xylene complex. This drips from the tube, leaving a fresh aluminium chloride surface. On the other hand, if the xylene/$AlCl_3$ complex be retained in the sphere of action by using a horizontal catalyst tube, appreciable yields of toluene may be obtained. In this latter case, similar to the usual liquid phase conditions, the xylene/$AlCl_3$ complex is formed initially, and then itself functions as a catalyst.

It is well known that the quantity of 'catalyst' used plays an important part in Friedel-Crafts syntheses; for example, whereas reaction 2 needs only small amounts, reaction 1 requires a molar quantity. Our work would suggest that two conditions determine this quantity: first, whether complex formation is necessary to make the reaction thermodynamically favourable; secondly, if a complex is formed, whether it is catalytically active. In the quantitative investigation of any particular synthesis, both factors require consideration. Equilibrium constants obtained by using catalysts of the type of aluminium chloride must be suspect unless they have been shown to be independent of catalyst concentration (for example, Pitzer's work on the xylene plus benzene reaction[5]).

Approval for publication has been granted by the Director-General of Scientific Research and Development, Ministry of Supply.

H. CAMPBELL.
D. D. ELEY.

Department of Colloid Science,
University, Cambridge.
May 12.

[1] Gustavson, *J. Prak. Chemie*, **68**, 209 (1903); **72**, 57 (1905).
[2] Menschutkin, *Chem. Abs.*, **3**, 1487 (1909); **5**, 1434 (1911).
[3] Reformatsky, *Chem. Zent.*, (i), 1226 (1901); (ii), 1372 (1901).
[4] Boedtker and Halse, *Bull. Soc. Chim.*, **19**, 444 (1916).
[5] Pitzer and Scott, *J. Amer. Chem. Soc.*, **65**, 803 (1943).

Reabsorption of Electrolytes in the Renal Tubules

REABSORPTION of electrolytes in the renal tubules has been examined for phosphates by Harrison and Harrison[1] and Smith, Ollayas and Winkler[2] in the dog, and by Barclay, Bray and Cooke[3] in man, and for chlorides by Hare, Hare and Phillips[4].

An examination of the available data at this stage may provide indication for future work and perhaps a basis for some standard system of imparting results.

We are in agreement with Harrison and Harrison[1] that the reabsorption of phosphates is directly related to glomerular filtration : if the glomerular filtration rate is plotted against the rate of phosphate reabsorption, the points fall along a straight line passing through the origin. We consider, therefore, that it is permissible to select any point on this line and use it as a reference point. The rate of glomerular filtration of 100 c.c. per minute is, we believe, convenient for two reasons : plasma values are usually expressed to 100 c.c. and, secondly, 100 c.c. would appear to be fairly close to the more recent determination of the average rate of filtration in man. On this basis, we find that the tubular reabsorption of phosphate, using a standard technique, is practically constant, but that alterations in technique do result in a different rate of reabsorption.

In the experiment of Hare *et al.*[4], we have plotted the rate of chloride reabsorption against filtration-rate, finding a straight-line relationship. Determination of the rate of chloride reabsorption per 100 c.c. glomerular filtrate shows that this is once more practically constant as is the case with phosphate ; the plasma level would appear to have no influence on the rate of absorption. This is perhaps even more evident if one plots the ratio of chloride absorbed per 100 c.c. glomerular filtrate to plasma chloride, instead of the ratio used by the authors. Thus plotted, their Fig. 2 is considerably altered ; 2·5 per cent sodium chloride falls well below 0·5 and 0·6 per cent sodium chloride. This is merely another expression of our point that a rise of plasma chloride does not affect the rate of reabsorption. If a similar procedure is adopted in the case of their Fig. 3, it is at once evident that pituitrin has no effect upon the rate of tubular absorption of chlorides. Hare *et al.* noted that if glomerular filtrate was increased, the reabsorption of chloride is increased ; when they state that they can find no upper limit to the threshold, they merely indicate that the tubules are able to cope with the increased chloride provided by the increased filtration to limits set by the inability of the organism to tolerate further increase of sodium chloride. When they state that they are unable to find a threshold value for chlorides, we would point out that the threshold, expressed as a rate of tubular reabsorption per 100 c.c. glomerular filtrate, is in the neighbourhood of 380 mgm. per 100 c.c. The reason for the increased excretion of chlorides during the glycosuria experiments would appear to be the lowering of the chloride threshold to 330 mgm. per 100 c.c. If one uses the method of ratios, when the reabsorption per 100 c.c. glomerular filtrate to the plasma value is less than one, then the threshold has been exceeded.

The use of percentage chlorides reabsorbed is preferred by Hare *et al.* rather than the absolute amount reabsorbed, presumably because they feel that the percentage is more constant than the absolute amount. This is, of course, a point of fundamental importance from the point of view of renal function. We have indicated above our reasons for preferring absolute amounts, but perhaps further examination will clear the way to future discussion. Evidence against a constant percentage absorption of chlorides is provided by the authors' own ratios. In the dogs with diabetes insipidus, the ratio is high ; on administration of pituitrin, the ratio falls. Careful consideration of the figures indicates that the difference in the ratios is due to the fact that while the diabetes insipidus dogs are reabsorbing less water, they are, as we pointed out, reabsorbing the same amount of chloride, and therefore the percentage of chloride must be high and so must be the ratio. If the percentage of chloride reabsorbed remains constant, then the excretion of chloride will vary directly with the volume of urine ; if the absolute amount remains constant, then excretion will vary directly with the plasma chlorides. Since Hare *et al.* point out that even when plasma chloride has fallen considerably, chloride is still present in the urine, and Smith[5] also makes the same point, perhaps it is as well to indicate the conditions which must be fulfilled if the urine is to become chloride-free. If the amount of chloride reabsorbed per 100 c.c. glomerular filtrate is the same as the plasma chloride, the urine will be free at all filtration-rates and all urine volumes ; if the percentage of chloride is constant, then urine will be chloride-free only for a certain definite percentage (higher than the plasma value), and for a certain definite filtration-rate and urine volume.

In either hypothesis the variability of the factors involved makes the likelihood of obtaining a chloride-free urine very small indeed.

To summarize, we believe that the electrolytes, at any rate those so far examined, have a definite threshold, but this threshold is not fixed once and for all, but, save under rigidly standard conditions, varies from time to time, probably under the influence of hormone balance. It does not appear to vary with the level of the electrolyte in the blood, although Smith, Ollayas and Winkler[2] have demonstrated an effect on threshold when the plasma-level is outside the normal physiological range. Lastly, the excretion of electrolytes, like that of water, is practically independent of rate of glomerular excretion ; and the tubule cells have apparently no upper limit to the amount they can reabsorb from an increasing glomerular filtration.

JAMES A. BARCLAY.

Department of Physiology,
The Medical School,
Hospitals Centre,
Birmingham, 15.

W. TREVOR COOKE.

Birmingham United Hospital,
Hospitals Centre,
Birmingham, 15.

[1] Harrison, H. E., and Harrison, H. C., *J. Clin. Invest.*, **20**, 47 (1941) ; *Amer. J. Physiol.*, **134**, 78 (1941).
[2] Smith, P. K., Ollayas, R. W., and Winkler, A. J., *J. Clin. Invest.*, **22**, 143 (1943).
[3] Barclay, J. A., Bray, H. G., and Cooke, W. T., *J. Physiol.* (in the Press).
[4] Hare, R. S., Hare, K., and Phillips, D. M., *Amer. J. Physiol.*, **140**, 334 (1943).
[5] Smith, H., "Physiology of the Kidney" (New York, 1937).

Permanence and Stability of Emulsion Systems

THE terms 'permanence' and 'stability' have often been regarded as synonymous when applied to emulsion systems. Until recently, neither term had a sufficiently rigid significance. In 1939, King and Mukherjee[1] defined the stability of an emulsion system as the reciprocal of the rate of change (with respect to time) of interfacial area, per unit area of initial emulsion interface. In this connexion the term 'specific interfacial area' ('specific surface', 'specific interface') may be expressed as being the number of square decimetres of interfacial area per gram of the dispersed liquid. These authors assumed that the rate of change of specific surface of an oil – water

emulsion is proportional to the initial specific surface (although in later work[2] they found that there appeared, in some cases, to be two rates, an initial rapid change, followed by a slower change), that is, according to the simpler assumption,

$$-\frac{ds}{dt} = k_1 s_1 = \frac{s_1}{k},$$

where s is specific surface ; s_1 is initial specific surface ; t is time ; k_1 is instability factor ; k is stability factor.

It will be observed that k, here, has the dimension of time. King and Mukherjee developed a method, based on the size-frequency analysis of the given emulsion system after various time-intervals, for the evaluation of k.

Lotzkar and Maclay[3] determined the comparative efficiencies of certain emulsifying agents by the application of a size-frequency technique to the emulsions formed using these agents, but the formula used in calculating the stability factor (k) of the emulsions was modified to :

$$-\frac{ds}{dt} = k_1 s = \frac{s}{k}.$$

In this formula also, k has the dimension of time.

In many technical processes emulsions are required to withstand such mechanical stresses as those imposed by shaking, vibration, centrifuging, temperature-change, impact, etc.

It is conceivable that where precaution is taken against the submission of the system to undue mechanical or other disturbance, an emulsion might display a high degree of permanence inasmuch as that comparatively little deterioration might occur on ageing ; whereas if it were subjected to some disturbance rapid deterioration might set in.

Such a system (a water – oil emulsion, sponsored by Mona wax) is described by Aherne and Reilly[4]. The emulsion, "a water-in-liquid-paraffin system", showed good permanence inasmuch as that no gross deterioration could be observed when it had aged for months, but even the most cautious addition of a light cover-glass to a sample of the emulsion (suitably diluted) on a microscope slide caused immediate coalescence of the water-globules of the sample in 'pools'. It is therefore questionable whether the terms 'stable' and 'stability' could, even in the ordinary restricted sense (since de-emulsification is, in the thermodynamic sense, an irreversible process), be applied to a system unable to withstand such slight mechanical disturbance. If the factor obtained as a result of size-frequency analyses at various time-intervals (precaution being taken against the submission of the system to undue mechanical disturbance) be called, in the case of such a system, a 'stability factor', the figure might be very misleading. It has been suggested, therefore, that the factor k (above) might, when the precaution aforementioned is taken in its determination, be termed a 'factor of permanence'.

J. C. AHERNE.
J. REILLY.

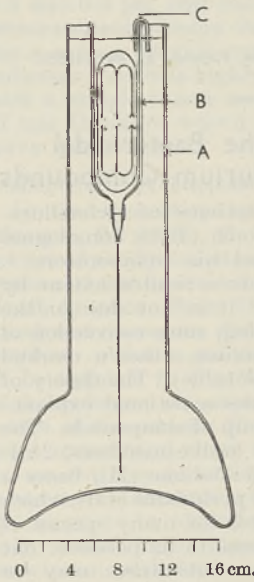
Chemistry Departments,
Crawford Municipal Technical Institute,
and
University College, Cork.
May 29.

[1] King and Mukherjee, *J. Soc. Chem. Ind.*, **58**, 243 (1939).
[2] King and Mukherjee, *J. Soc. Chem. Ind.*, **59**, 185 (1940).
[3] Lotzkar and Maclay, *Ind. and Eng. Chem.*, **35**, 1294 (1943).
[4] Aherne and Reilly, *Sci. Proc. Roy. Dubl. Soc.* (1944) (in the Press).

An Apparatus for Low-Temperature Dialysis

BOTH speed and low temperatures are highly desirable in the dialysis of sensitive protein solutions. Unfortunately, when small refrigerators are used instead of cold rooms, the apparatus used to increase the velocity of dialysis has to be sacrificed to space requirements. For example, the Kunitz[1] dialyser, in which a stream of pure water is allowed to flow over a rocking dialysis sac containing a marble, cannot be set up in an ordinary laboratory refrigerator.

If a dialysis sac containing a salt solution is suspended in water, the greater density of the solution dialysing out causes it to flow downwards, and currents can be seen streaming away from the bottom of the sac. In the dialyser described below, an attempt has been made to utilize this fact to set up a circulation which results in a constant supply of fresh water to the outside of the dialysis sac. The apparatus consists of a tall dialysis vessel A of about 7·5 cm. diameter by 40 cm. high containing a second flow-directing vessel B about 15 cm. total length by 3·5 cm. in diameter ending in a jet. The dialysis sac is placed in the inner vessel, and the water in the inside and outside vessels connected by a syphon C of approximately 2 mm. bore.



The flow of the denser salt-containing fluid out through the jet can be easily followed either by direct observation or by placing a flash-lamp bulb on one side of the vessel about 1 ft. away and a sheet of paper on the other side at a similar distance, when a Schlieren picture of the stream will be projected on to the paper. The fine stream of fluid from the jet passes almost to the bottom of vessel A without breaking up, and even after it has broken up the fragments continue on their way downwards. This flow results in the dense salt solution collecting at the bottom of vessel A, while fresh water is being continuously supplied around the dialysis sac. The process lasts for 24–48 hours, depending on the initial volume and concentration of the dialysing fluid, and continues until the salt solution has risen to the level of the jet.

Simultaneously, another circulation is taking place inside the sac. It can be observed by watching the movement of small particles of dust, etc., just inside the membrane, where the fluid, owing to loss of salt, rises slowly, while that in the centre of the sac falls, resulting not only in mixing inside the sac but also in the maximum differential salt concentration being developed across the membrane due to the counter current principle. The flow of fluid inside and outside the membrane also helps to abolish skin effects which restrict diffusion due to stagnant surface layers.

The dimensions of the apparatus, especially height of vessel A and jet size, play an important part in efficiency. We have not observed unbroken flow

streams of more than 20 cm. from jets used, and it therefore seems that no great increase in efficiency would result from making the apparatus any taller. The optimum diameter of the jet appears to be about 0·4 mm.

The dialysis time for a 0·5 saturated ammonium sulphate solution under these conditions is about thirty hours, and the final concentration inside the sac is approximately 1/500 of the initial concentration, that is, of the order of 0·1 mgm. nitrogen/c.c. This dilution corresponds to 1/12 of the concentration that would occur if all the salt in the sac were to be evenly distributed throughout the whole volume of the dialysate.

To avoid salt contamination of the water in the outside vessel, the apparatus is set up as follows. The dialysis sac is placed inside vessel *B*, and *B* is then lowered into *A*, which already contains the approximately correct volume of water. When the inside and outside levels are the same, the syphon is filled and dropped into place.

The term 'gravity dialyser' is suggested for the apparatus.

J. S. FALCONER.
D. B. TAYLOR.

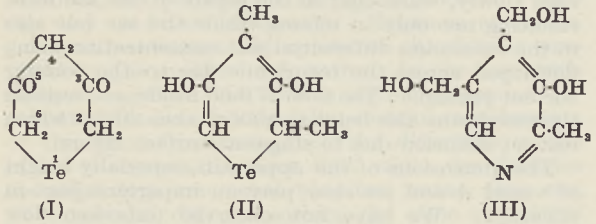
University of London,
King's College,
Strand, W.C.2.
June 5.

[1] Kunitz, M., and Simms, H. S., *J. Gen. Physiol.*, **11**, 641 (1928).

A Speculation on the Bactericidal Activity of certain Tellurium Compounds

THE intense bactericidal activity of *cyclo*telluropentane-3 : 5-dione (I) and some of its homologues was reported by Morgan and his collaborators[1–4]. This property is shared only to a limited extent by other tellurium compounds; it is not due to the lability of tellurium in this ring, since conversion of (I) into its equally labile dioxime causes a marked drop in bactericidal power (see table). The theory of substrate competition[5] provides a rational explanation of the activity of this group of compounds. The formula of one of the highly active members, 2 : 4-dimethyl-*cyclo*telluropentane-3 : 5-dione (II), bears a striking resemblance to that of pyridoxine (III), which is known to be a growth-factor for many species of micro-organisms[6–8], and it seems to us possible that the relation between the two substances may be similar to that between *p*-amino-benzoic acid and sulphanilamide[9,10].

In the present circumstances, we are unable to test this hypothesis experimentally; but the following facts may be adduced in its support, the data on *B. coli communis* being drawn from the table. Similar results are available[2] from experiments on *B. typhosus*, *Staph. pyogenes aureus* and *Strep. hæmolyticus*.



(I) (II) (III)

(i) The bactericidal effect requires the presence of an enolic hydroxyl group in the 3-position of the *cyclo*telluropentane-3 : 5-dione ring. When enolization is prevented (the dioxime) or inhibited (the 4 : 4-diethyl compound) the effect is less marked. A hydroxyl occurs in the corresponding position of the pyridoxine molecule.

(ii) The bactericidal effect is sensitive to the nature and position of substituents in the *cyclo*telluropentane-3 : 5-dione ring. The 1 : 1-dihalides are inactive and the strongly polar 4-chloro-compound has only very weak activity. Unsubstituted *cyclo*telluropentane-3 : 5-dione is moderately effective, but the introduction of small alkyl groups (methyl or ethyl) in the 2-position greatly enhances the bactericidal power; larger alkyl groups (propyl, butyl or amyl) are less effective. A methyl group in the 2-position characterizes the pyridoxine molecule.

Pyridoxine bears an alkyl substituent in the 4-position, and 4-alkylated derivatives of *cyclo*telluropentane-3 : 5-dione are considerably more active than the parent substance. The 2 : 4-dimethyl compound is second equal in activity in the series which was tested.

If the arrangement $N.C(CH_3).C(OH).C$ may be regarded as of fundamental bacteriological significance in the pyridoxine structure, it should be noted that the most active tellurium derivatives tested, 2 : 6-dimethyl and 2 : 6-diethyl *cyclo*telluropentane-3 : 5-dione, contain this arrangement twice, nitrogen being replaced by tellurium.

Compound	Mean effective concentration
*Cyclo*telluropentane-3 : 5-dione (CTPD)[2]	1 in 500,000
CTPD-3 : 5-dioxime[4]	1 in 166,000
4 : 4-Diethyl CTPD[2]	1 in 900,000
4-Chloro-CTPD[11]	1 in 12,500
2-Methyl CTPD[2]	1 in 3,000,000
2-Ethyl CTPD[2]	1 in 3,000,000
2-Propyl CTPD[2]	1 in 1,200,000
2-Butyl CTPD[2]	1 in 700,000
2-Amyl CTPD[2]	1 in 500,000
4-Methyl CTPD[2]	1 in 900,000
4-Ethyl CTPD[2]	1 in 2,500,000
4-Butyl CTPD[2]	1 in 2,800,000
2 : 4-Dimethyl CTPD[2]	1 in 5,000,000
2 : 6-Dimethyl CTPD[2]	1 in 9,000,000
2 : 6-Diethyl CTPD[2]	1 in 5,000,000

Should our general hypothesis be correct, it seems possible that compounds related to *cyclo*telluropentane-3 : 5-dione, but containing oxygen or sulphur instead of tellurium, might have correspondingly high bactericidal or bacteriostatic properties without the alarming toxicity which makes *cyclo*telluropentane-3 : 5-dione itself quite impossible for therapeutic use.

J. MASSON GULLAND.
W. V. FARRAR.

Chemistry Department,
University College,
Nottingham.
May 7.

[1] Morgan, Cooper and Burtt, *Biochem. J.*, **17**, 30 (1923).
[2] Morgan, Cooper and Burtt, *Biochem. J.*, **18**, 190 (1924).
[3] Morgan, Cooper and Corby, *J. Soc. Chem. Ind.*, **43**, 304 *T*(1924).
[4] Morgan, Cooper and Rawson, *J. Soc. Chem. Ind.*, **45**, 106*T* (1926).
[5] Fildes, *Lancet*, **238**, 955 (1940).
[6] Möller, *Z. physiol. Chem.*, **254**, 285 (1938).
[7] McIlwain, *Brit. J. Expt. Path.*, **21**, 25 (1940).
[8] *Ann. Rev. Biochem.*, **9**, 400 (1940); **10**, 352 (1941); **11**, 326 (1942); **12**, 554, 557 (1943).
[9] Woods, *Brit. J. Expt. Path.*, **21**, 74 (1940).
[10] *Ann. Rev. Biochem.*, **12**, 561 (1943).
[11] Calculated from data of Morgan and Drew, *J. Chem. Soc.*, **121**, 922 (1922).

RESEARCH ITEMS

Carbohydrate Metabolism after Burns

IT is well known both in man and animals that there is a rise in the level of blood sugar during the first few hours after a burn. E. J. Clark and R. J. Rossiter (*Quart. J. Exp. Physiol.*, **32**, 269 and 279; 1944) have studied the changes in carbohydrate metabolism produced by experimental skin burns in rats and rabbits. During the first three hours following a burn there is hyperglycæmia, rise of blood lactate, decrease of muscle glycogen, and either no change or a decrease in liver glycogen. The increased blood sugar comes chiefly from the muscle glycogen via the liver (Cori cycle). All these changes, except for the liver glycogen, could be reproduced by injection of adrenaline into normal animals. Injection of adrenaline into rats and rabbits always causes a rise of liver glycogen. Further, it was shown that liver slices from the burned animals formed glycogen from glucose (*in vitro*) much less readily than did liver slices from normal animals, whereas liver slices from adrenaline-injected animals formed glycogen normally. The authors conclude that the changes are mainly due to the liberation of adrenaline, but that in addition there must be some other factor acting on the liver, either accelerating glycogen breakdown or inhibiting its synthesis. Results of other workers suggest that some factor in addition to adrenaline is also at work in the hyperglycæmias of hæmorrhage and asphyxia. There is no clue as to what the additional factor may be, but it is probably common to burns, hæmorrhage and asphyxia.

Spanish Mackerel

CAPTAIN IAN S. R. MUNRO has published a most useful work in his "Revision of Australian Species of Scomberomorus" (*Mem. Queensland Mus.*, **12**, Part 2; Nov. 1943). The Spanish mackerel comprise an important group of deep-sea food fishes which support a valuable coastal pelagic fishery in Australian waters, particularly Queensland, northern New South Wales and Western Australia. The industry is based primarily on the barred Spanish mackerel *Scomberomorus* (*Cybium*) *commerson*, caught by trolling in coastal waters, but there is a small net fishery of *Scomberomorus* (*Cybium*) *queenslandicus* sp. nov., which enters the estuaries along the coast during the winter months. Several other marketable species are caught in smaller numbers. All these, like their relatives from overseas, are first-class food fishes, and the larger forms provide good sport for game anglers along the coast of New South Wales and the Great Barrier Reef. A decline in the annual catches in spite of improvement in technique and equipment is due partly to a large increase in fishing activities during the spawning seasons. Investigations concerning the biology and economics are in progress, and the present work deals with the exact diagnosis and subsequent identification of all species. Four species are shown to occur in Australian seas. All members of the family are coastal inhabitants, and throughout the world they are seldom found in water deeper than forty fathoms. Some migrate into estuarine waters at certain seasons. Most of the species inhabit the clear tropical waters of ocean currents around rocky islets and coral reefs, tide rips and off-shore currents. Their preference for waters of low density and medium salinity apparently accounts for their coastal distribution. Good figures of the Australian species are given.

Carbon Dioxide as a Measure of Grain Infestation

R. W. Howe and T. A. Oxley of the Pest Infestation Laboratory at Slough discuss a method intended to give at least an approximate measure of insect infestation of grain in a short time. In this connexion it was thought that the rate of carbon dioxide production of infested grain, as a measure of metabolism, would probably be a satisfactory measure of infestation. The very different methods in use are either laborious or consume a great deal of time. While the carbon dioxide method gives less detailed information than the existing and more laborious methods, it has the great advantage over them of giving an estimate of the actual amount of damage which an infesting population is causing. The authors describe (*Bull. Entomol. Res.*, **35**, 11; April 1944) a detailed technique for the routine determination of the carbon dioxide output of samples of grain. The carbon dioxide figure obtained is largely a measure of insect infestation of the sample of grain tested, and a table is given by which the numbers of various species of grain infesting insects may be estimated from the carbon dioxide figure. Clean grain of less than 15 per cent water content produces up to 0·25 per cent carbon dioxide in twenty-four hours at 25° C., so that results up to 0·3 per cent are considered to indicate clean grain. A result between 0·3 and 0·5 per cent indicates slight infestation or a water-content of more than 15 per cent. Grain showing a carbon dioxide content of 1 per cent or more indicates that it is highly unsuitable for storage. In such a sample this is an indication of an infestation of one Calandra weevil larva per 500 grains or 33 larvæ per pound.

Embioptera or Web-spinners of the New World

IN the *Proceedings of the United States National Museum*, **94** (1944), E. S. Ross gives an admirable review of the systematics of the Recent and Tertiary species of the insect order Embioptera of North and South America. Some 71 American species are recognized and these are distributed in 17 genera and 6 families. All the genera excepting Oligotoma seem to be endemic to the New World. The systematics of the order are almost entirely based upon the characters of the males. The females are neoteinic to a great extent and show but few characteristics. So far no features have been discovered to enable the genus or even the family of the females or of immature specimens to be identified. The best, or almost the only means, is to identify these by their definite association with known males. It is interesting to note that in the New World there are in the Clothodidæ species showing the most generalized structural features of the order, and in the genera Oligembia and Chelicerca those showing some of the highest specialization. The memoir, which extends to more than one hundred pages, includes 156 very clear text-figures illustrating structural details of the various species together with one photographic plate of wing venation. A work of this kind greatly aids in the identification of the insects concerned, and it is hoped that it will stimulate field collectors and students to devote attention to this peculiar but neglected order of insects.

Witches' Broom of the Cacao

AN interesting study of the ecology of a parasitic fungus is described by R. E. D. Baker and S. H. Crowdy (Memoir No. 8, Dept. of Mycology and Bacteriology, Imp. Coll. Trop. Agric. Trinidad, Jan.

1944). The paper deals with field studies and control methods of the witches' broom disease of cacao, caused by *Marasmius perniciosus*. The malady has assumed serious proportions of recent years, and several types of broom have been described in earlier publications. Broom formation is maximal in January or February, and minimal in June or July. Cacao trees bloom all the year round, and cushion brooms are strongly and positively correlated with the numbers of flowers at any one time. The disease appears to be more closely associated with flowering than with vegetative growth. Shoot growth flushes five or six times a year, and fan brooms appear with the flush, though the total amount of shoot growth has little effect upon the numbers of brooms. It can apparently affect pods only at an early stage of development. Eradication of the fungus by direct methods does not appear to be feasible, and the search for immune or highly resistant varieties of cacao seems to provide the only practicable possibility of control.

Development of the Eye in Drosophila

A. G. STEINBERG (*Proc. U.S. Nat. Acad. Sci.*, **30**, 5; 1943) has shown that the character 'bar eye' in Drosophila is controlled by the reduced size of the eye disk in embryo and by the fate of labile cells in the larval stage. These cells may either take part in eye formation or be transformed into chitin, according to the influence of external or internal causes. For mutants such as the 'lobes' and 'eyeless' in *D. melanogaster*, it would be interesting to know whether they developed in a similar way. Steinberg provides evidence that this is the case.

Electrical Resistance Strain Gauges

A PAPER read recently in London by S. F. Dorey before the Institution of Mechanical Engineers deals with the measurement of static strains using electrical resistance strain gauges in conjunction with a Wheatstone bridge, and having a cathode ray oscillograph instead of the usual galvanometer. The advantages of this arrangement are indicated in the paper, and it is shown that stresses so low as 250 lb./sq. in. can be measured readily under workshop conditions, provided the correct technique is applied. Methods of calibration of this equipment and also its use in two specific problems are described.

Bonding and Earthing of Single-Core Cables

AN article by E. A. Beavis and C. W. Schofield (*Eng. Supp. Siemens Magazine*, No. 216, April/May 1944) discusses the provisions which should be made for the bonding and earthing of metal-sheathed single-core paper-insulated lead-covered cables in three-phase installations. The subject is considered from the points of view of the sheath voltages which arise when the cables are bonded and earthed at one point only, and of the circulating currents which flow along the sheaths when multiple bonding and earthing is employed. The type of installation to secure minimum transmission losses, characteristics of various types of installations, earthing and bonding for various types of installations, and theoretical considerations of induced voltage and sheath current are discussed and, finally, the authors give some practical test results. The investigation covers cables for voltages of from 1 kV. to 33 kV., of cross-sectional areas of 0·25–1·5 in.^{2} according to voltage, and at cable spacings ranging from 2 in. to 120 in. Provided sheath voltages are not allowed to reach dangerous values, especially under fault conditions, it is concluded that earthing and bonding at one point is the ideal arrangement.

Flow of Current between Electrodes on a Metal Surface

A PAPER by the late Prof. W. M. Thornton describes investigations carried out on this subject (*J. Inst. Elec. Eng.*, **91**, Pt. 2, No. 20; April 1944). Measurements of the thickness of metal plates or tubes from one side only can now be made by a direct-current electrical method. In the 'four points in line' method a low voltage is applied by point contacts to the surface and the potential drop between them observed. In B. M. Thornton's 'six points in line' method there are two pairs of points on which the potential is observed, and in Warren's 'eight point' method the electrodes are arranged in two squares. On account of the spread of the current, the readings on the potential points differ and their ratio is an indication of the thickness of the plate. The six- and eight-point methods give values for the thickness that are independent of the resistivity of the metal. The theory of the flow of current between two electrodes in an infinite plate is well known; but the surfaces to be examined for thickness are in practice restricted in area and have boundaries which are not always of regular shape. The influence of proximity of the electrodes to a free edge has been previously examined. The paper deals with the flow of current between point electrodes in circular and elliptical areas, a square, a rhombus, narrow and wide lenticular areas and a narrow lune. The flow between points on the surface of metal tubes is considered. Results obtained by the 'six points in line' method are quoted and a collection of derived formulæ is added.

Flow of Fluid through a Nozzle

THE equations of motion of a compressible fluid, such as steam, through a nozzle present great difficulty even when the fluid is assumed to have no viscosity. Osborne Reynolds's well-known treatment (1886) applied only to the one-dimensional case when the velocity was uniformly distributed over each cross-section. In two dimensions very few exact solutions are known, and these relate to cases which are not realizable in practice. Rayleigh (1916) proposed a method of successive approximations. Taylor and Sharman (1928) used an electrical analogue to obtain solutions by experiment; their method failed when the speed exceeded the local speed of sound. A recent paper by J. R. Green and R. V. Southwell (*Phil. Trans. Roy. Soc.*, A, **239**, 367; 1944) gives an approximate numerical method based on Southwell's general method of 'relaxation', which he has applied to a whole series of engineering problems. Given the shape of the nozzle, the first step is to use a conformal transformation of this shape into a rectangle. The exact differential equations are replaced by approximate equations of finite differences, which are easier to solve. Then, in accordance with the relaxation technique, the error of these approximations is expressed in terms of 'residual forces', and finally these 'forces' are 'liquidated', that is, reduced to negligible magnitudes. Like the electrical method, the relaxation method fails when the speed exceeds that of sound. An alternative method, not yet fully worked out, is proposed to deal with this case.

AMINO-ACID MIXTURES AS AN ADDITIONAL FOOD FOR PREMATURE INFANTS

By J. HENNING MAGNUSSON

Pediatric Clinic attached to the Caroline Institute, Norrtull Hospital, Stockholm

IT is generally agreed that human milk is far superior to all other foods for premature infants, and this form of nutriment seems to be one of the essentials for a low mortality. As a rule, however, these infants have begun their extra-uterine life far too early, and in their case, therefore, breast milk cannot be said to be the ideal nourishment to the same extent as it is for those born at term. In the rearing of premature infants, also, there is the question of supplying food in sufficient quantities to be met, a factor which need not be considered with full-term babies. This difficulty is especially noticeable in the case of small infants whose weight at birth is considerably below 2,000 gm. To cover the high calory requirements of these infants solely by means of human milk, with its 70 or so calories per decilitre, places a high demand not only on the holding capacity of the stomach but also on the digestive organs as a whole. It should be remembered, also, that in nearly all premature infants the digestive organs are functioning below par, during the first weeks at least.

Because of the tendency of these infants to develop acute inanition, a regular feeding regimen must be started early; but only small amounts of breast milk can be given during the first days. The amounts supplied must be kept strictly within the limits of the minimal food requirements for life, and overfeeding must be as conscientiously avoided as underfeeding. Increases in food are made only very gradually, and the smaller and the more premature the infant the greater the care which must be exercised. Further increases in amount are based on the weight of the infant and on the infant's food tolerance.

When the premature infant is fed on human milk, the weight curve, after the initial drop, not infrequently remains almost horizontal for the first three, or even four weeks of life. After that, it begins gradually to rise, so long as no complications, in the form of intercurrent infections, arise.

Various supplementary foods have been tried with the view of increasing the calories the infant receives through the breast milk. In the majority of cases these have consisted of small feeds of a concentrated cow's milk mixture, the main purpose with these being to meet the large requirements of mineral salts and protein. Other observers have tried additional feeds of casein or glucose, or a mixture of both of these.

The premature infant requires a diet which is readily assimilable and rich in proteins. An amino-acid mixture ought to be capable of fulfilling these conditions, especially in view of the fact that amino-acids of low molecular weight are absorbed as easily as sugar while whole protein molecules are not absorbable. There is also reason for believing that infants at this early stage of development have an imperfectly functioning enzymic mechanism, and that, because of this, they cannot properly assimilate the ordinary foods. If this is really the case, then the unsatisfactory gain in weight so often observed during the first weeks of life must be nothing more or less than a sign of starvation.

Since November 1943, I have been experimenting with amino-acid mixtures as a supplement to human milk. More than thirty infants have been treated, and uniformly good results have been obtained. In the pediatric literature which has found its way to Sweden under the present war-time restrictions, I have only succeeded in finding two reports on the use of amino-acids as an additional food for young infants[1,2]. The feeding of amino-acid to prematurely born infants, on the other hand, does not seem to have been tried.

The amino-acid mixture used is 'Aminosol', manufactured by Vitrum, of Stockholm, a preparation worked up by Drs. E. Jorpes and K. A. J. Wretlind, of the Department of Chemistry, Karolinska Institutet. It is prepared by enzymic disintegration of casein followed by dialysis of the amino-acids, and it contains 80–85 per cent free amino-acid. As the yield of the starting material is 80–100 per cent in this preparation, the amino-acid content can be said to be the same as in casein. Glucose was added to the amino-acid mixture in order to supply calories. To meet the salt requirements, Osborne-Mendel salt mixture was also added. Thus the preparation used in my experiments ('Aminosol'-glucose) had the following composition: amino-acid mixture 25 per cent, glucose 25 per cent, and salt mixture 1·5 per cent.

In most instances the mixture was given through a catheter concurrently with the breast milk during the first days, or weeks, of life, and later by the oral route. The question of dosage has not yet been definitely established. As a rule, the daily dose given

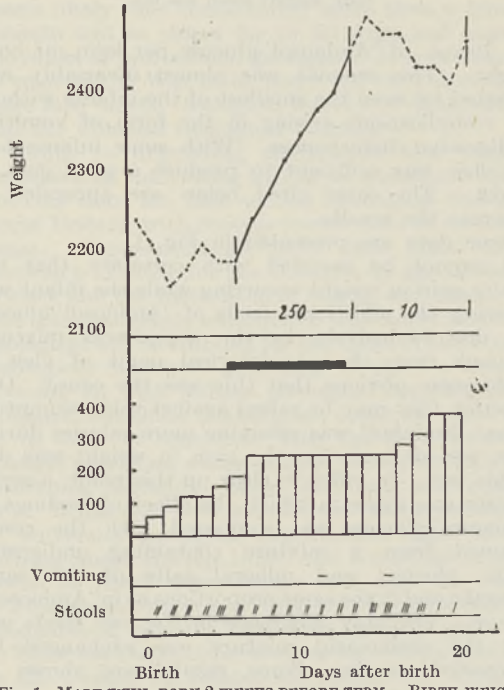


Fig. 1. MALE TWIN, BORN 2 WEEKS BEFORE TERM. BIRTH-WEIGHT, 2,160 GM.

In the weight curve, - - - - - - - - - indicates periods during which the infant received breast milk only, and . — . — . periods in which it was supplemented by 'Aminosol'-glucose. The figures between the vertical lines below the weight curves show the weekly gain in weight, and ▬▬ equals 'Aminosol'-glucose (10 c.c. daily per kgm.) as additional food.

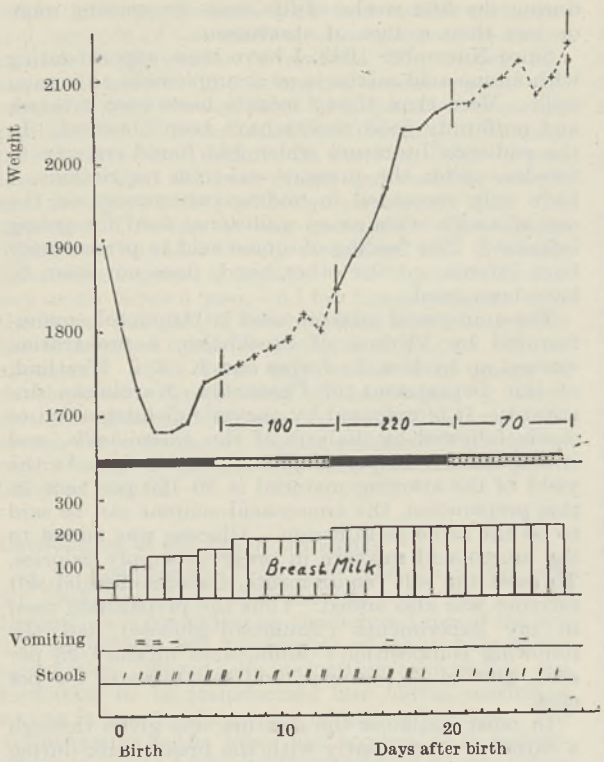


FIG. 2. GIRL, BORN 1 MONTH BEFORE TERM. BIRTH-WEIGHT, 1,960 GM.

In the weight curve, + - - + - - indicates periods in which the infant received, in addition to the breast milk, undigested casein plus glucose plus salt mixture, and the 'ladder' below indicates the amount of this mixture (10 c.c. daily per gm. body weight) which was fed.

was 10 c.c. of 'Aminosol'-glucose per kgm. of body weight. This amount was almost invariably well tolerated by even the smallest of the infants without any complications arising in the form of vomiting or digestive disturbances. With some infants half this dose was sufficient to produce a good gain in weight. The cases cited below are appended to illustrate the results.

Some data are presented in Fig. 1.

It cannot be asserted with certainty that the greater gain in weight occurring while the infant was receiving the additional feeds of 'Aminosol'-glucose was due exclusively to the amino-acid mixture, although from the physiological point of view it would seem obvious that this was the cause. One objection that may be raised against this assumption is that the infant was receiving more calories during these periods and that the gain in weight was due to this fact. In order to clear up this point, a series of tests was made in which the effect of feedings of 'Aminosol'-glucose was compared with the result obtained from a mixture containing undigested casein, glucose, and mineral salts of the same strengths and in the same proportions as in 'Aminosol'-glucose. The only difference in the two foods was that the amino-acid mixture was exchanged for undigested casein. Some results are shown in Fig. 2.

In all the tests in which the effect of the amino-acid mixture was compared with that of undigested casein, the gain in weight was much greater in the periods during which the amino-acid mixture was being fed. Thus the amount of calories we supplied through this additional food cannot in itself have been the reason why the infant put on so much extra weight. The cause is undoubtedly to be sought in the feeding of amino-acids. To judge from certain cases, it would almost seem as if the amino-acids are used quantitatively for protein synthesis, since the daily weight increase was approximately equal to the gain in weight which would be obtained through protein synthesis and binding of the corresponding amount of water.

[1] Shohl, A. T., Butler, A. M., Blackfan, K. D., and MacLachlan, E., *J. Pediat.*, **15**, 469 (1939).

[2] Hill, L. W., *J. Amer. Med. Assoc.*, **116**, 2135 (1941).

TEACHING OF PLANT GENETICS

ON February 20, 1943, Dr. W. Burns, agricultural commissioner with the Government of India, delivered his presidential address to the Indian Society of Genetics and Plant Breeding on the subject of the teaching of plant genetics in India (*Indian J. Genetics and Plant Breeding*, **3**, 1 ; 1943). His comprehensive survey and discussion of this question, based as they are on a wide experience of the application of genetics to Indian agriculture, call for consideration in some detail.

Dr. Burns thinks that the rudiments of genetics should form part of the liberal education of those who proceed beyond the secondary school, because our behaviour and reaction to many situations must be profoundly affected by our understanding of the part played by heredity. A general raising of the level of biological teaching in schools is one of the essential prerequisites of teaching genetics and would enable "the future citizen, administrator or specialist to handle problems dealing with living things, including man, less ignorantly". The specialist in biology, medicine or agriculture requires, of course, a wider knowledge of genetics, since there are few biological problems the genetical aspects of which can be safely neglected. The plant breeder must have available to him all the resources of genetical science.

Genetical teaching is bound to be affected by the rapid and, in some ways, uneven growth of the subject. The necessary perspective could be introduced by a short historical survey. Elementary courses in genetics should aim at making clear the basic concept of the genotype and the chromosome theory of heredity, and should be preceded by a botany course and an introduction to biometrical mathematics. Instruction in cytology should be included in the botany course, and should involve the making of simple preparations of dividing nuclei. Practical work in elementary genetics itself would of necessity be largely on prepared material in the laboratory.

The biological specialist requires an additional preliminary course in floral biology to acquaint him with the structure and action of different floral mechanisms, the operation of incompatibility, and the methods used in making controlled pollination by artificial means. The genetical course itself should begin with a biometrical study of naturally occurring variation, proceeding via the distinction between heritable and non-heritable variation to Mendelism and chromosome theory. The student should count

segregating families and so be led to an understanding of sampling variation and tests of goodness of fit. Finally, the bearings of genetics on evolutionary theory and taxonomy should be made clear, with special reference to complex, or polygenic, inheritance. This would require that the teachers themselves should have studied the problem carefully, and should have "some form of belief and not merely a chaos" in their minds. Dr. Burns also recorded a protest against the tyranny of the herbarium method and a plea for a fuller study of living plants in taxonomy.

With reference to the plant breeder, it is clear that he should receive a fuller mathematical training than the other classes of student, for otherwise he must acquire it "painfully, perhaps self-taught" at a later and less convenient stage. He should also have a more comprehensive course in genetics, though it could be modelled on the lines sketched earlier. He would require an introduction to the modern theory and practice of field experiments, with practical work involving responsibility for an actual trial. The part to be played by statistics was discussed in relation to the danger of an undue adherence to statistical methods leading to a neglect of the living plants. The solution is essentially that of training the breeder to rely primarily on observations of, and familiarity with, his crop; and to show him how his observations can be amplified and checked by statistical analyses.

Dr. Burns concluded with a survey of the present position of genetics teaching in India, which he found far from satisfactory. He advocated the giving of preliminary instruction in the universities and of advanced courses in agricultural institutes. Above all, if this genetical teaching is to be fruitful the students must be led to grow plants and study them as living things. The provision of facilities for this should not be too great a tax on the resources of educational establishments; but there is a need for a small hand-book of practical genetics using the plants, chillies, rice, etc., with which Indians are familiar.

This discussion of teaching in plant genetics is noteworthy in a variety of ways, but especially perhaps for its insistence on the following points:

(1) The argument for the wider teaching and appreciation of general biology and the genetical point of view.

(2) The introduction of perspective into genetics by the approach through observable variation in Nature and the linking of genetics to evolutionary theory and taxonomy.

(3) The need for preliminary courses in floral biology and mathematics, and the introduction of modern statistical methods into the teaching.

(4) The emphasis on relating genetics teaching to the living organism as a corrective to over-formalization.

It must be remembered that Dr. Burns was discussing plant genetics in India, and so his various points may not apply with equal emphasis to all genetics in all countries. His separation of cytology from genetics and its inclusion in the botany course, for example, will not be desirable everywhere. Nevertheless, his conclusions and proposals merit the careful study of all who are concerned with genetics and its teaching. His remarks are indeed especially timely in view of the expansion of genetics and genetical teaching which must now be contemplated in Great Britain.

GEOLOGISTS IN THE POST-WAR PERIOD

THE total number of British geologists wholly engaged in a professional capacity in pre-war years was probably less than six hundred, nearly one quarter of whom were occupied in the teaching of the science, principally in the universities. To some extent this high proportion of geologists engaged in academic spheres is due to the fact that large classes of technical students in mining, metallurgy, civil engineering, and agriculture require tuition in geology as a part of their professional training.

The Geological Society of London has recently given evidence on the post-war recruitment of professional geologists, to the Inter-Departmental Committee on Further Education and Training, under the chairmanship of Lord Hankey. After expressing the hope that geology should be introduced into the schools as a fundamental study in general science courses, the Society stressed the important part that geologists play in the discovery and development of mining fields and oilfields, and in many branches of civil engineering.

In spite of the importance of geological work, the normal pre-war number of fully-trained geologists graduating each year from British universities is only about thirty. Although there have been wide fluctuations in the demand for mining and oil geologists, as a result of trade cycles, the supply of suitable men has usually been inadequate. It is probable that there will be a still greater dearth of British-trained geologists in the immediate post-war period, owing to the requirements of industry, Government Geological Surveys, and university teaching staffs. Within two years after the cessation of hostilities, it seems likely that considerably more than a hundred recruits will be called for to fill gaps and augment the ranks of professional geologists. It is certain that as soon as the War ends, there will be a demand for more men on the Geological Survey of Great Britain and the Colonial Geological Surveys.

Owing to impending retirements and proposed expansion of staff, there will be an immediate call for not less than ten men on the Geological Survey of Great Britain, with further recruitment in succeeding years. Representations have been made to the Secretary of State for the Colonies by the Geological Society and the Institution of Mining and Metallurgy, and it is confidently anticipated that many additional geologists will be enrolled for the staffs of the Colonial Geological Surveys. Not only is there a need for pressing on with routine geological mapping in the Colonies, but there is also great scope for more work to be done in connexion with the development of mineral resources, water supply, public works (dams, reservoirs, harbours, roads, etc.), and soil conservation. It has also been pointed out that several heads of university geological departments must soon be retiring under the age limit, and a number of junior posts in these departments will also be vacant. Within recent years new avenues of employment for geologists in industry have been opening up.

There are ample opportunities for trained geologists in the British oil companies, which face immediate post-war projects necessitating the employment of geological staffs larger than heretofore. Oilfields in Burma and elsewhere in the Far East will have to be re-opened, and studies must be made of the effect of Japanese operations, and of the best means of re-

suscitating the oilfields. To offset damage to operating fields, exploration to discover new ones must be accelerated. British interests, whether co-operating or competing with those of the United States, must enlarge their fields of action, and they will need to engage large staffs of oil geologists to do this effectively. Moreover, geologists in oil companies are continually being attracted out of the exploratory phase into production and field management.

In addition, after the War there is likely to be a widespread development of young mining fields and a general exploration for new metallic and non-metallic mineral deposits, which will involve the services of many mining geologists. Such men must also be recruited into the Government Geological Surveys in greater numbers than has hitherto been the practice.

GRAVITATION, ELECTROMAGNETISM, AND QUANTUM THEORY

A RECENT paper by Einstein and Bargmann[1] declared that "Ever since the theory of general relativity has been developed there has existed the problem of finding a unified theory of the physical field by some generalization of the relativistic theory of gravitation . . . a decisive modification of the fundamental concepts is unavoidable". Schrödinger[2] has also explained the need for a generalization of Einstein's original postulates in order to unify the theories of gravitation, electromagnetism, and the mesonic field responsible for binding the nucleus. There is no danger of the work of Einstein and Schrödinger being overlooked, but there is great danger that what is apparently an investigation of great importance, namely, "The Theory of Indeterminate Space-Time", by F. R. Saxby, may be missed by physicists, as it appears not in any of the usual scientific journals, but in the *Bulletin of the Research Laboratories of the National Cash Register Company* (pp. 13–72, September 1943), of which laboratories he is mathematics staff engineer.

Mr. Saxby proceeds on something like the general lines of the recent work of Einstein and Schrödinger, being influenced, like them, by the variations introduced into the original relativity theory by Weyl and Eddington; but his treatment has one strikingly original feature, which seems to link up quantum theory with relativity. If this claim can be substantiated, a great advance has been made. As Schrödinger[2] remarked: "At the back of our striving for a unitary field theory, the great problem awaits us of bringing it into line with quantum theory. This point is still covered with deep mist."

It is difficult to give a summary of Saxby's paper without complicated mathematics, but at any rate it can be indicated how it is related to Schrödinger's investigations. Both agree that the first step is to assume, as a postulate, that a certain correspondence exists between two vectors at two neighbouring points of space, or more generally between two *tensors* at two neighbouring points of space-time. The relation assumed is of a special form, known technically as an 'affine connexion'. It contains sixty-four arbitrary coefficients. In Einstein's original theory there were certain additional assumptions which restricted these coefficients, in particular an assumption of symmetry. Both Schrödinger and Saxby emphasize the non-symmetric case, the former to account for the meson field, the latter to account for the quantum. In both cases the gravitational part of the theory is much the same as in Einstein's older theory, but there are novelties in the electromagnetic part, particularly in Saxby's treatment, which differs radically from any previously given. It is claimed that the new theory links up the indeterminism of the electromagnetic potentials with Heisenberg's principle of uncertainty.

Mr. Saxby admits that much has yet to be done in developing his theory, and it is to be hoped that he will be able to publish an account of it in periodicals usually taken by university libraries. Einstein's own new investigations[1] go more deeply into the purely mathematical side of the correspondence between two tensors, but he says: "whether we have succeeded in approaching the solution of this physical problem [that is, that of a unified theory of physics] is still uncertain. The answer to this question depends, among other things, on a mathematical problem which we have not yet been able to solve".

H. T. H. PIAGGIO.

[1] Einstein, A., and Bargmann, V., *Ann. Math.*, **45**, 1 (1944).
[2] Schrödinger, E., *Nature*, **153**, 572 (1944).

IMPERIAL FORESTRY INSTITUTE, OXFORD

THE nineteenth annual report of the Imperial Forestry Institute, Oxford, for 1942–43 is inevitably coloured by war conditions. It proves somewhat difficult for those interested but not connected with Oxford to distinguish the actual staff of the Department or School of Forestry from that of the Imperial Forestry Institute; in other words, the part of the forestry staff maintained by the University of Oxford from its own funds as compared with the grants expended upon the Institute coming from Government sources, Forestry Commission, several Colonies, and so forth.

As the report remarks, the Forestry Commission has issued a White Paper (Cmd. 6447) on future forest policy in Great Britain, which has not yet received the sanction of the House of Commons. A Supplementary Report (Cmd. 6500. London: H.M. Stationery Office, 2*d*. net), dealing with the forest policy of private woodlands, was published early in 1944. There had been controversy on the proposals in the first White Paper for the treatment of the private landowner and his woodlands (which had provided the bulk of the timber and other forest materials required for the War) and considerable opposition became apparent throughout the country. A conference was held between the Forestry Commission and representatives of landowners and forestry societies, and the reconsidered proposals agreed upon, mainly connected with the help which could be granted to private landowners towards afforesting and re-afforesting their felled-over lands, were published in the Supplementary White Paper.

The portions of the White Paper alluded to in the Imperial Forestry Institute's report are the sections on education and research, which particularly concern the Institute. It appears that during the year the Committee for Forestry at Oxford considered a report on the future policy of the Institute drawn up by a sub-committee. The report was adopted with certain modifications, "but it was considered necessary to keep it pending the expected publication

of the views and proposals of H.M. Forestry Commission on Post-War Forestry Policy in this Country". It is difficult to appreciate the reason for the above statement.

The Imperial Forestry Institute is an Empire organization, or at its inauguration was intended as such. Practically the whole of the forest wealth of the Empire is outside the British Isles and must remain so for many years to come. Research work is presumably one of the important branches of the Institute, and it would appear reasonable that closer co-operation in such work would be at least as necessary as with the Forestry Commission, which is so stressed in the report. Moreover, there are other universities with forest departments ready to undertake research work in collaboration with the Forestry Commission; but there is only one Imperial Forestry Institute, and that is situated at Oxford.

The suggestion for raising the status of the Institute from a pass to an honours school is a wise and far-sighted move.

The only students under instruction during the year were the Colonial forestry scholars, four attending the Institute, two of whom were forestry graduates. There was also one candidate for B.Sc., and one for D.Phil. working under the supervision of the professor of forestry.

A NEW MEXICAN VOLCANO

P. D. TRASK has recently given a preliminary account of the inception and growth of a new volcano, El Parícutin, situated about two hundred miles due west of Mexico City (*Trans. New York Acad. Sci.*; Dec. 1943).

Prof. L. C. Graton, professor of mining geology at Harvard, spent nearly two months in the region making trips to it and flying over it twice; and he describes its growth in *Sky and Telescope* of February. A well-illustrated article on the volcano also appears in the *National Geographic Magazine* of February 1944.

The first intimation of awakening activity was the occurrence in February 1943 of numerous earthquakes in the district. On February 19 some three hundred shocks were reported. The next day a Tarascan Indian farmer was astonished to see 'smoke' spiralling up from a hole in a field which he was ploughing.

That night the first explosion occurred, and since then—at least up to the end of the year—the volcano has been erupting steadily. Within a week the cone reached a height of 550 ft. and by late September it had grown to 1,500 ft. During the early days explosions in quick succession expelled a cylindrical column of ash which, after reaching a height of some hundreds of feet, suddenly formed dark expanding clouds that billowed up to 6,000 – 8,000 ft., when steam began to condense, after which the ash cloud became progressively whiter until it passed into a horizontal cloud of curling puffs of vapour at about 15,000 – 18,000 ft. Later on, much of the fragmental material consisted of red-hot bombs, blown 2,000 – 3,000 ft. into the air. A cone 100 ft. high was built up in the course of the first day.

Two days after the birth of the volcano, lava emerged from a field about a quarter of a mile from the crater and continued to flow for six weeks, by which time it was more than a mile long and 100 ft. thick. Early in June eight lava flows issued from the cone itself. The crater at this time was occupied by lava to within 50 ft. of the rim, and through the congealed blocky surface ashes were being erupted. It was observed that each flow was preceded by a phase of violent explosive activity, but that while lava was actually escaping, explosions were relatively few. By September several other flows had broken through the flanks of the cone. The lava consists of andesitic basalt of essentially the same type as that erupted by the hundreds of older and now apparently extinct volcanoes that occur within a radius of about seventy-five miles around Parícutin.

It is of interest that the only previous volcanic activity in the region, within the memory of man, occurred in 1759 when the celebrated new volcano of Jorullo suddenly appeared, some fifty miles to the south-east of Parícutin, and built a 1,000-ft. cone in five months of activity.

NATIVE RESERVES IN SOUTH AFRICA

THE Native Reserves provide homes for one third of the South African population, and constitute the chief source of labour for mines and industries. Soil wastage, resulting from over-stocking and primitive methods of agriculture, is rapidly converting the reserves into deserts. A memorandum, drawn up at the suggestion of the Cape Town Branch of the Association of Scientific Workers of Southern Africa, puts forward a comprehensive scheme of reorganization*.

A start might be made in the following terms with certain limited areas, and the new system gradually extended until it covers the entire Reserves. (1) An ecological survey of the given area; (2) the area to be fenced and made into suitable paddocks for summer and winter grazing; (3) all scrub bulls to be culled and the necessary number of good bulls to be provided; (4) progressive limitation of cattle to the estimated carrying capacity of the land. It would be a good thing to regard each area as a collective farm, and each communal farm should have a communal centre with offices, hall for meetings and lectures, perhaps a school building, barns and silos, sheds for storage, etc. An African agricultural officer, as general adviser, should be stationed at each farm. Families would be entitled to their own plots of arable land fenced off from the communal land. Though encouraged to store and market collectively, the individual peasant would be entitled to the products of his own land, and individual ownership of cattle would have to be tolerated. All able-bodied members of the *commune* would be expected to provide a minimum amount of labour under the management of a committee. Technical training schemes would also be desirable.

It is realized that certain major changes in South African governmental policy—improvement in the social and commercial conditions of Africans outside the Reserves and provision of more land and industrial opportunities within—must accompany any serious attempt to deal with the general problem.

K. L. LITTLE.

* Association of Scientific Workers of Southern Africa. Research Memorandum, No. 3. The Native Reserves and Post-War Reconstruction. By Edward R. Roux. (Cape Town.) 6*d*.

FORTHCOMING EVENTS

Wednesday, July 19

IRON AND STEEL INSTITUTE (joint meeting with the SHEFFIELD BRANCH OF THE INSTITUTE OF BRITISH FOUNDRYMEN) (at the Royal Victoria Station Hotel, Sheffield), at 7 p.m.—Mr. P. C. Fassotte: "Developments in the Design and Use of Side-Blown Converter Plants".

Thursday, July 20

LONDON MATHEMATICAL SOCIETY (at the Royal Astronomical Society, Burlington House, Piccadilly, London, W.1), at 3 p.m.—Mr. G. A. Barnard: "Some Applications of Modern Higher Algebra to Engineering Statistics".

Friday, July 21

GENETICAL SOCIETY (in the Department of Comparative Anatomy, University Museum, Parks Road, Oxford), at 12 noon—Annual Meeting.

APPOINTMENTS VACANT

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

DEMONSTRATOR (man or woman) IN THE DEPARTMENT OF INORGANIC AND PHYSICAL CHEMISTRY—The Secretary, Bedford College for Women, Regent's Park, London, N.W.1 (July 17).

LECTURER IN MATHEMATICS AND PHYSICS—The Director, Robert Gordon's Technical College, Aberdeen (July 18).

TEACHER (full-time) OF MATHEMATICS, SCIENCE and DRAWING, mainly for employment in a new Junior School of Building—The Secretary, Bridgwater Art and Technical Institute, 142 Chilton Road, Bridgwater, Somerset (July 19).

EDUCATIONAL PSYCHOLOGIST (full-time) to work in the Child Guidance Clinic and in connexion with Schools and Institutions—The Director of Education, Education Offices, Deansgate, Manchester 3 (July 20).

SCIENCE MASTER or MISTRESS for the Boys' Junior Technical and Day Continuation School—The Organizer of Further Education in Rugby, College of Technology and Arts, Eastlands, Rugby (July 21).

ASSISTANT MASTER (Graduate preferred) to teach MATHEMATICS and SCIENCE, particularly CHEMISTRY—The Headmaster, Eastbourne Junior Technical School and Evening Institute, The Grange, St. Anne's Road, Eastbourne (July 22).

SUPERINTENDENT OF THE ENGINEERING DIVISION of the National Physical Laboratory—The Director, National Physical Laboratory, Teddington, Middx. (July 22).

LECTURESHIP IN CHEMISTRY—The Registrar, The University, Reading (July 24).

LECTURER IN MECHANICAL ENGINEERING—The Registrar, King's College, Newcastle-upon-Tyne (July 24).

LECTURER FOR MECHANICAL OR AERONAUTICAL ENGINEERING SUBJECTS—The Secretary, Northampton Polytechnic, St. John Street, London, E.C.1 (July 24).

LECTURER (full-time) IN PHYSICS AND MATHEMATICS in the Engineering Department of the Schools of Technology, Art and Commerce—The Chief Education Officer, City Education Office, 77 George Street, Oxford (July 24).

CHEMISTS (temporary) with considerable experience in analysis of metals—The Ministry of Labour and National Service, Room 432, Alexandra House, Kingsway, London, W.C.2 (quoting Reference No. F.2628A) (July 25).

CHAIR OF MATHEMATICS tenable at the Royal Holloway College—The Academic Registrar, University of London, c/o Richmond College, Richmond, Surrey (July 26).

LECTURER IN EXPERIMENTAL PHYSIOLOGY—The Registrar, The University, Sheffield (July 28).

SUPERINTENDENT OF THE LIVERPOOL GAS COMPANY'S CENTRALIZED CONSTRUCTION AND WORKS MAINTENANCE DEPARTMENT—The Personnel Superintendent, 18–26 Bold Street, Liverpool 1 (July 29).

ASSISTANT SECRETARY to the Oxford and Cambridge Schools Examination Board—The Chairman of the Oxford Delegacy, St. Catherine's Building, St. Aldate's, Oxford (July 31).

ASSISTANT LECTURER IN THE DEPARTMENT OF MATHEMATICS, an ASSISTANT LECTURER (temporary) IN THE DEPARTMENT OF PHYSICS, and an ASSISTANT LECTURER (temporary) IN THE DEPARTMENT OF ENGINEERING (with special qualifications in Electrical Engineering)—The Registrar, University College, Singleton Park, Swansea (August 5).

SENIOR TECHNICAL OFFICER (temporary) at London Headquarters of the Ministry of Town and Country Planning—The Ministry of Labour and National Service, Room 432, Alexandra House, Kingsway, London, W.C.2 (quoting Reference No. EA. 950A) (August 10).

READERSHIP IN PHYSICAL ANTHROPOLOGY—The Registrar, University Registry, Oxford (August 31).

CHAIR OF ELECTRICAL ENGINEERING—The Acting Registrar, The University, Leeds 2 (September 30).

SECRETARY—The Hon. Secretary, Illuminating Engineering Society, 32 Victoria Street, London, S.W.1.

LECTURER (full-time) IN THE SCIENCE DEPARTMENT (principal subjects: Inorganic, Organic and Physical Chemistry, with subsidiary Physics)—The Registrar, Merchant Venturers' Technical College, Bristol.

PSYCHIATRIC SOCIAL SERVICE WORKER for the Glasgow Royal Mental Hospital and associated Out-patient Clinics—The Medical Superintendent, Glasgow Royal Mental Hospital, 1055 Great Western Road, Glasgow.

GRADUATE TEACHER OF GENERAL SCIENCE OR GENERAL ENGINEERING SUBJECTS in the Burton-on-Trent Technical Institute and Junior Technical School—The Secretary and Director of Education, Education Offices, Guild Street, Burton-on-Trent.

SENIOR MASTER with good Honours Degree in Science or Mathematics, and an ASSISTANT MASTER with Degree in Science or Mathematics, in the Leeds Central High School—The Director of Education, Education Offices, Leeds 1.

ASSISTANT MASTER qualified to teach ENGINEERING SUBJECTS and MATHEMATICS up to Ordinary National Certificate standard—The Principal, Technical Institute, Beckenham Road, Beckenham, Kent.

TEACHER OF MATHEMATICS, PHYSICS AND CHEMISTRY, and a TEACHER OF MECHANICAL ENGINEERING, ELECTRICAL ENGINEERING and BUILDING—The Principal, Technical College, Bradford Place, Walsall.

LABORATORY ASSISTANT IN THE DEPARTMENT OF PHYSICS—The Bursar and Acting Registrar, University College of North Wales, Bangor.

REPORTS and other PUBLICATIONS

(not included in the monthly Books Supplement)

Great Britain and Ireland

Proceedings of the Royal Irish Academy. Vol. 49, Section A, No. 12: The Point Charge in the Unitary Field Theory. By Erwin Schrödinger. Pp. 225–236. 1*s*. Vol. 49, Section A, No. 13: Unitary Field Theory; Conservation Identities and Relation to Weyl and Eddington. By Erwin Schrödinger. Pp. 237–244. 1*s*. Vol. 49, Section A, No. 14: On the Cascade Production of Mesons. By H. W. Peng. Pp. 245–258. 1*s*. 6*d*. Vol. 49, Section A, No. 15: The Shielding Effect of Planetary Magnetic Fields. By James McConnell and Erwin Schrödinger. Pp. 259–274. 1*s*. Vol. 49, Section A, No. 16: The Union of the Three Fundamental Fields (Gravitation, Meson, Electromagnetism). By Erwin Schrödinger. Pp. 275–288. 1*s*. 6*d*. Vol. 49, Section A, No. 17: The Paths of the Particles in a Vortex Street. By W. B. Morton. Pp. 289–292. n.p. Vol. 49, Section B, No. 14: Note on the Physiology of the Mammalian Epididymis and Spermatozoon. By Lawrence Collery. Pp. 213–224. 1*s*. Vol. 49, Section B, No. 15: Molecular Rearrangements of Phenyl Styryl Ketone Oxides. By Joseph Algar and James McKenna. Pp. 225–250. 1*s*. (Dublin: Hodges, Figgis and Co., Ltd.; London: Williams and Norgate, Ltd.). [136

Science and Industry. Reports of the Meetings arranged by the Manchester Chamber of Commerce in collaboration with the Department of Scientific and Industrial Research. Pp. 63. (Manchester: Manchester Chamber of Commerce.) 1*s*. 6*d*. [146

Imperial Agricultural Bureaux. Joint Publication No. 6: Alternate Husbandry. Pp. 158. (Aberystwyth: Imperial Agricultural Bureaux.) 5*s*. [146

Scientific Proceedings of the Royal Dublin Society. Vol. 23 (N.S.), No. 22: The Gametophytes of *Podocarpus andinus*. By W. J. Looby and J. Doyle. Pp. 222–237+plates 6–9. 3*s*. 6*d*. Vol. 23 (N.S.), No. 23: Report of the Radium Committee for the Year 1943. P. 238. n.p. (Dublin: Hodges, Figgis and Co., Ltd.; London: Williams and Norgate, Ltd.). [156

The Morphology and Biology of *Culex molestus*: Observational Notes for Investigators. By John F. Marshall. Pp. iv+16. (Cheltenham: The Author, 47 London Road.) 1*s*. [266

The Control of Land Use. (Cmd. 6537.) Pp. 16. (London: H.M. Stationery Office.) 3*d*. net. [266

Institute of Welding. Twenty-first Annual Report of the Council: Accounts and Balance Sheet for 1943–44. Pp. 22. (London: Institute of Welding.) [266

University of London. Report of the Principal on the Work of the University during the Year 1943–44. Pp. 6. (London: University of London.) [266

Other Countries

Carnegie Institution of Washington. Publication 552: The Mutants of *Drosophila melanogaster*. By Calvin B. Bridges. Completed and edited by Katherine S. Brehme. Pp. vii+257+3 plates. (Washington, D.C.: Carnegie Institution.) 2.50 dollars. [146

Uganda Protectorate. A Working Plan for Settlement Forests in Lango District, Uganda. By C. S. Cree. Pp. 24. (Entebbe: Government Printer.) [146

The Maine Bulletin. Vol. 46, No. 11 (University of Maine Studies, Second Series, No. 59): The Woody Plants of Maine; their Occurrence and Distribution. By Fay Hyland and Ferdinand H. Steinmetz). Pp. xix+72 (8 plates). (Orono, Maine: University of Maine.) 50 cents. [146

Memoirs of the American Philosophical Society. Vol. 21: Sumerian Mythology, a Study of Spiritual and Literary Achievement in the Third Millennium B.C. By S. N. Kramer. Pp. xiv+125+21 plates. (Philadelphia: American Philosophical Society.) [156

Fouad I University. Bulletin of the Faculty of Science, No. 17: Flora of Egypt. Vol. 1: Pteridophyta, Gymnospermæ and Angiospermæ, part Monocotyledones: Typhaceæ—Gramineæ. By Vivi and Gunnar Tackholm, in collaboration with Mohammed Drar. Pp. 574. (Cairo: Fouad I University.) [266

Société des Nations: League of Nations. Lexique polyglotte des maladies contagieuses: Contribution à la Nomenclature nosologique internationale. (Polyglot Glossary of Communicable Diseases: Contribution to the International Nomenclature of Diseases.) Par le Dr. Yves Biraud. (Reprinted from the *Bulletin of the Health Organisation*, Vol. 10, No. 3, 1943–44.) Pp. 201–556. (Geneva: League of Nations; London: George Allen and Unwin, Ltd.) 4*s*. [266

Twenty-sixth Annual Report of the National Research Council of Canada, 1942–43. (N.R.C. No. 1169.) Pp. 36. (Ottawa: National Research Council of Canada.) [276

Lord Rutherford. By Prof. T. H. Laby. Pp. 16. (Melbourne: Whitcombe and Tombs, Ltd.) [296

Catalogue

Soya Flour: Make your Dishes more Nutritious. Pp. 4. (Elstree: Soya Foods, Ltd.)