NATURE

"To the solid ground
Of nature trusts the Mind that builds for aye."—Wordsworth

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NATURE

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LEADERSHIP AND INCENTIVES IN INDUSTRY

THE attention which has in recent months been focused on management, as shown, for example, in the formation of the Administrative Staff College, of which Mr. Noel F. Hall has recently been appointed principal, in the recommendations of the Percy Committee on Higher Technological Education regarding training for management, and in the proposals of the Baillieu Committee for the establishment of a British Institute of Management, has sprung from two main roots. First, there is wider recognition of the importance of a higher standard of management if we are to increase the technical efficiency of British industry and to secure the best use of our resources of man-power and woman-power. This approach is emphasized, for example, in the report of the Working Party for the Cotton Industry which, welcoming the formation of an Administrative Staff College, urged also that the central body for the industry should direct attention to arrangements for providing instruction in the principles of management. The second factor is the realization of the important contribution of management in establishing the right relations and co-operation on which industrial efficiency depends, particularly in the changed social conditions of a state of full employment.

Both these factors are discussed by Colonel L. Urwick in a stimulating paper, "Administration and Leadership", contributed to a recent issue of the *British Management Review*, and they are reflected in a series of monographs on higher management which are being published by the Department of Industrial Administration of the Manchester Municipal College of Technology. These monographs are the outcome of a conference of industrialists in the Manchester area during May 1945, which resulted in a course of four lectures for senior executives, the first of which was delivered by Colonel L. Urwick on "Patterns of Organisation", the subsequent ones being by Sir Arthur Fleming on "The Impact of Science on Industry", Mr. T. G. Rose on "The M nsuration of Management", and Mr. C. G. Renold on "The Employer and the Social Fabric". It is also intended to include in the series reports and pieces of research work undertaken by the staff of the Department and its senior research students. The monographs thus represent a definite step towards providing the instruction in the principles of management suggested by the Cotton Working Party in its report and also towards encouraging the research on matters affecting industrial employment which the Working Party likewise recommended.

Colonel Urwick, in the paper first mentioned, maintains that administration and leadership are the two principal functions of those whose responsibility it is to govern, or participate in the government of, social groups. By administration he understands the aspect of managem nt or government which is concerned with the activities of forecasting, planning, organising, commanding, co-ordinating and controlling the work of the group, whereas leadership is

concerned with the personal, human, dynamic aspect of the total task of government, which renders such aspects an art rather than a science. Further, he believes that the central industrial problem of our time is how to present the purposes of our co-operative systems of an executive character so that they gain and retain the willing, spontaneous co-operation of those who do not participate and cannot participate in determining those purposes. Pure administration is not enough, nor is trying to imitate the processes of political democracy ; and accordingly he maintains that the most important subject for industrialists to study to-day is leadership.

Colonel Urwick expounds Mr. Ordway Teed's definition of leadership as winning the will to co-operate from those whose co-operation is needed, and making the purposes of the joint undertaking explicit and continuously attractive to those who share the burden of attaining them. The core of sound human relations in any form of organised endeavour lies in the identity of the individual with the purposes of the group, opportunity for the individual to grow within the group and equity in the treatment of the individual by the group. Colonel Urwick, stressing that every business must have a social purpose, suggests that British employers are missing an opportunity for leadership in this direction. Unless the leader is convinced of the rightness of the cause, he cannot convey that conviction to others, and these are the essential conditions if he is to represent the group he leads.

Next among the functions of leadership, Colonel Urwick places initiative ; third comes administration —a complementary part of the process of government—and finally the function of int rpretation, which joins hands with the initiative function and is of vital importance in the task of education and the creative settlement of dispute. It is only through personal leadership of this type that he thinks it is possible to satisfy the aspirations towards a more democratic spirit in the ordering of our systems of co-operation for executive purposes ; and he concludes by emphasizing the importance in facing the difficulties in the transition from war to peace of an adequate supply of leaders at all levels. That involves four things : the arrangement of our organisations so that the opportunity for, and the responsibility of, clear-cut executive leadership are obvious at every level ; the utmost care in selecting future leaders ; use of equal care in developing subordinate leaders ; and perfecting and expanding our arrangements for the formal training of leaders. It is probably in the last respect that we are weakest. Much can be done to develop the natural qualities of a potential leader by systematic study, and Colonel Urwick urges that we need a national staff college for industry, comparable with the Staff College at Camberley. Strong executive leadership, he maintains, is essential to democratic government to-day—in industry no less than in politics.

The bearing of Colonel Urwick's remarks on the current situation is even more apparent in the emphasis which he places on the separation of the policy-making or planning level from the operational or executive level. The distinction is vital if we are to avoid either endless confusion as to what is involved in the nationalization of industry, or hopelessly to prejudice the work of the joint industrial councils or other means of securing the common outlook and co-operation upon which industrial and social efficiency alike depend. Both Colonel Urwick and Mr. Renold drive home this same point in their lectures in the series of monographs on management. "It is not government which is inefficient," Colonel Urwick points out, "but forms of organisation which fail to distinguish between planning and performance, between political and administrative processes" ; and he proceeds to emphasize both the inefficiency which results from a board of directors muddling executive management instead of sticking to policy, and the dangers which lie in the tendency for the spheres of political and business leadership to become more and more intermingled.

But there is much else in this lecture which provides food for thought at the present time. Quoting the considered opinion of Lilienthal that, in creating the Tennessee Valley Authority, "Congress adopted and wrote carefully into law the basic principles and practices of modern management", Colonel Urwick notes that the common weakness in such public corporations is failure to provide for adequate executive leadership of the group as a whole. Using his study and experience of military organisation, Colonel Urwick here develops ideas which are as pertinent to industrial organisation as to the regional organisations which we must now contemplate in the development of health services and the reorganisation of local government in Britain.

It is, in fact, in this second part of his lecture, in which after discussing the unit he turns to what he calls the formation, that Colonel Urwick is most suggestive and stimulating. Insisting on the vital importance of a proper balance and integration of theory and practice, he argues trenchantly for the new staff college for industry, and suggests that if its graduates are not successful when they go into industry, then the blame may well be the short-sightedness of business leaders who refus d to devote sufficient time for the purpose. He would prefer to start with few students and little publicity, relying on the effect of turning out a first-class product as the result of the first two or three courses.

Colonel Urwick does not forget that business can offer few positions comparable with that of the staff officer in the Services, but he remarks pertinently that it is only by taking thought that any man can add to his administrative stature ; and his observations on the concealed losses of human quality due to mechanical supervision and lack of imagination and critical thinking are much to the point. Similarly, in the first part of his lecture, he stresses the biological analogies in discussing human systems of co-operation, and his enunciation of the principles of organisation and of the methods of grouping activities whether by kinds or by levels of authority and responsibility, keeps this aspect clearly in mind ; similarly, he picks out the critical points in the normal development of an economic undertaking

from small beginnings as a one-man affair. The scalar principle, the principles of specialization, of correspondence of authority and responsibility, and of the span of control, are expounded as clearly as in his earlier writings; and in pointing out the dangers which attend the growth of any undertaking, Colonel Urwick gives clear guidance as to the ways in which these dangers can be avoided, and new and appropriate patterns of organisation developed.

Mr. Renold's approach to his subject is of a different order but no less suggestive. Mankind, he holds, has struck its tents and is seeking new pastures, a new mode of life, a new world; and in reviewing some of the changing features in our industrial system, he stresses first the emergence and general acceptance of the conception that the industrial worker has citizen rights in industry. Such rights must clearly be associated with duties; but Mr. Renold points out, though less lucidly than Colonel Urwick, that the analogy between the political and the industrial field breaks down at the executive level. Unless there is agreement on common objectives, the claim that employees should participate with employers in the appointment of management officials becomes farcical.

Mr. Renold stresses the importance of seeking objectives in industry which are acceptable to the public, the workers and the owners, and meanwhile he points out that it is quite practicable to reach agreement between management and representatives of the various grades of employees on what may be termed domestic law, such as the works rules, terms of employment and the like. Administration is a different question, and because of its repercussions on efficient administration and particularly in team-building, he questions the practicability of an independent judiciary for breaches of domestic law. The problem is, of course, part of the difficult one of building up general morale, and becomes less acute as we succeed in finding common objectives; and Mr. Renold has much to say about the development of new loyalties, which he ranks high among the duties forming the counterpart of rights in the conception of industrial citizenship.

Something much more than profit-sharing or co-partnership is required: it is fundamentally the question of arousing interest in a man's daily work. A common objective, a conviction on the part of each member that he has a personal contribution to make, and the knowledge that his contribution is recognized: these are essential conditions for successful team-building and the inherent loyalty it implies. Mr. Renold suggests that the Training within Industry Scheme offers possibilities in this connexion; but commenting on the extreme complexity and close integration that now characterize economic life, he believes that a national wage policy is also essential. The settlement of wage disputes can no longer be left to the process of collective bargaining, because the community as a whole has just as vital a stake in the outcome as the parties themselves. In this he is in agreement with Prof. H. S. Kirkaldy, who insisted in his inaugural lecture at Cambridge that this is one of our most urgent needs. Finally, he points to the growing acceptance of the idea of a social purpose in industry, and suggests that the general set-up of industry should be such as to provide a soil in which the spirit of service can grow, and that the conduct of industry should be such as to cultivate that growth. Nationalization, he believes, may provide an answer to the institutional or formal aspect, but is liable to fail in regard to conduct or leadership, and he suggests that both the forms of industry and the leadership must be modified.

Mr. Renold may be too confident of the ability of private enterprise to provide the leadership that is required. Given the training and the sense of common purpose, leaders of the right calibre would probably be thrown up in similar proportions by public or private enterprise: the emphasis comes on enterprise and initiative, and the form of organisation must be such as to promote these. But this lecture, and those of Colonel Urwick, are a challenge and a stimulus to constructive and creative thinking on both the forms and the practice of management, and they reinforce all those arguments which have been advanced in the report of the Baillieu Committee, the report of the Percy Committee on Higher Technological Education, and in those of the Working Parties for the Cotton Industry, the Boot and Shoe Industry and the Pottery Industry, for greater attention to this question of the quality of management and the closer investigation of the many factors that affect the health, efficiency and interest of the workers.

The monographs which the Department of Industrial Administration of the Manchester College of Technology has thus initiated are both a useful contribution to the literature of industrial management in Great Britain, the quality of which was adversely criticized by the Percy Committee, and also a welcome indication of the increasing extent to which the nation is prepared to support the newly established Administrative Staff College and the British Institute of Management. The Department's activities hold promise of a solid contribution to the work of building up a new structure in industry which will satisfy alike the demands for increased mechanical efficiency and the human needs and social purposes of an era of full employment. The Tavistock Institute of Human Relations is also breaking fresh ground in setting itself the task of finding out more about the underlying pyschological factors in social relationships such as industrial groups, and removing some of the obscurity which clouds human motivation. Lord McGowan has testified to the discipline, the desire to work and the greater sense of responsibility observed in those returning from the Services to work in the great firm of which he is chairman, and he has referred also to the urgent need for industrialists to make an intensive effort to break down fears of unemployment, to uproot suspicion and to arouse interest in efficiency and production.

Much more time must indeed be devoted by management to explaining the problems and operations of industry to the employees, and the proposals for the training of managers and administrators will not by themselves suffice. There must be a simul-

taneous effort to provide the technical training in management that is required at lower levels; for example, at what may be termed the 'non-commissioned officer' or foreman level of industry. More than good personnel management, however, is essential if effective incentives, and especially the social incentive, are to be developed in industry. Simultaneously, research must proceed into operating conditions and problems of human relations, so that the trained managers at every level may have fuller facts at their command in reaching decisions and framing or executing policy. Above all, there must be enlisted the interest and co-operation of the trade unions themselves, both in the selection and training of men and in the research into human and operating problems, in order that we may build up the sense of common purpose, the understanding and good will which form the basis of morale in industry as elsewhere. The achievement of such an end demands also open mindedness and the readiness to discard prejudices, obsolete forms and practices, no less on the side of the workers than of management, and for their contribution to that end alone these monographs deserve a warm welcome.

THE LEPIDOPTERA OF SWEDEN

Svenska Fjärilar

Systematik bearbetning av Sveriges Storfjärilar, Macrolepidoptera. Av Frithiof Nordström och Einar Wahlgren. Pp. iv+86+354+50 plates. (Stockholm: Nordisk Familjeboks Förlags A.-B., 1941.) 115 kr.

THIS splendidly printed and illustrated monograph, although bearing the date 1941, has only recently come to hand. It is under the general editorship of the well-known entomologist, Albert Tullgren, who contributes an introduction. Being of quarto size, a very large amount of information is provided in its 440 pages, and nearly every species of the Swedish Macrolepidoptera is figured in its fifty coloured plates. The so-called Microlepidoptera are left for future treatment. The monograph is divided into two parts which, for some reason or other, have separate pagination. Part 1 is devoted to general structure, habits, protective resemblance, distribution, etc., together with keys to the various families. It also contains a general bibliography of a limited kind; and runs to eighty-six pages with sixty-six text-figures and twelve distributional maps. In the latter, the range of each of the species shown is indicated by individual dots representing each locality, as has been done in E. B. Ford's recent volume on "British Butterflies". Part 2 constitutes the bulk of the monograph, and in its 354 pages (the subject-matter of which is arranged in double columns) will be found the essential information regarding the Swedish species, their range of distribution in that country, the larvæ and their food-plants. Some 369 text-figures portray genitalic characters and those features shown by the caudal extremity in great numbers of the pupæ. The coloured plates are of general all-round excellence: they are chromolithographs that give an accurate life-like representation of the adult insects and many of their larvæ. We do not recollect having seen finer coloured plates of their kind illustrating Lepidoptera, notwithstanding the large number of works that have been published on this order of insects.

Beginning with the butterflies, these are divided into Rhopalocera and Grypocera. It is interesting to note that *Papilio machaon* ranges over the greater part of the country and that *Lycæna arion* is widely distributed over the southern half. The distribution of the various species of Lepidoptera, it may be added, is indicated by laens or districts (except in the twelve maps already alluded to). Apparently neither *Apatura iris* nor *Limenitis camilla* is found in Sweden; but the handsome *L. populi*, on the other hand, ranges over most of the southern half of the country besides being found in the islands of Öland and Gottland. Among species with a restricted range is *Polyommatus hylas*, which is confined to Malmohus and Blekinge, together with the two larger islands just mentioned. Among the Vanessinæ, the genus *Brenthis* with nine species is well represented. One species, *B. frigga*, has a wide range north of Stockholm. Altogether some 108 species of butterflies are included as being Swedish. This relatively high number is partly accounted for owing to the arctic element in the fauna being well represented.

Among the moths, the account begins with the Sphinges, which include the same species as those found in Britain. The Notodontidæ include our British species along with several others such as *Notodonta phœbe*. It is interesting to learn that *Leucodonta bicoloria*, so rare in the British Isles, is widely distributed in southern Sweden. The Lasiocampidæ and Lymantriidæ comprise all the British members, together with such striking species as *Dendrolinus pini* in the first-named family and *Dasychira abietis* in the latter. The Noctuidæ are very well treated. The genus *Catocola* has no fewer than seven Swedish representatives and, among them, *C. fraxini* seems to have the widest range. In addition to the last-named there are a number of other species that have but a casual or very localized foothold in Britain and a very extensive distribution in Sweden. Notable instances are *Athetis* (*Hydrilla*) *palustris* and *Zygæna meliloti*. The Arctiidæ are very well represented in the Swedish fauna by a number of striking members, including *Rhyparia purpurata*, *Hyphoraia alpina* and *H. festiva*, that do not range into Britain. The usual British Hepialidæ (here spelled Hepiolidæ) occur together with the local *Hepialus* (*Hepiolus*) *canna*. The Zygænidæ have nine species and the Aegeriidæ (or Sesiidæ) fourteen, while the Psychidæ also comprise fourteen species and the Talæporiidæ four. The last-named family follows the Psychidæ and is not regarded, therefore, as belonging to the Tineidæ as some authorities believe.

A well-worked group of insects such as the Macrolepidoptera affords admirable material for faunistic comparisons. In this connexion the present work is invaluable since it provides the relevant data in a concise form. While the majority of British Lepidoptera range into Sweden, the richer fauna of the latter country contains many species that are not to be found in Britain. Except for the handicap of being written in the Swedish language, British lepidopterists could adopt this volume as a general work of reference. For many, the plates alone would prove of great assistance for purposes of general identification aided by such a work as that of Meyrick. The nomenclature used does not agree in many cases with that adopted in the latest British list by Kloet and Hincks. It follows, in general, a less heterodox

and more usual system. Sufficient synonymy is quoted to avoid confusion, and it is outside the scope of this notice to cavil at differences of nomenclature. We extend congratulations to all concerned in the production of this volume, that will prove an admirable reference book both for the naturalist and the collector.

A. D. IMMS

NATURE IN THE FIELD

Fisherman Naturalist

By Anthony Buxton. Pp. 190+39 plates. (London and Glasgow: Wm. Collins, Sons and Co., Ltd., 1946.) 10*s.* 6*d.* net.

ANTHONY BUXTON, already well known because of his book, "Sporting Intervals at Geneva", has in his "Fisherman Naturalist" produced one of the best Nature books in recent times. One of the charms of this book is that the author writes entirely from his personal experiences—and they have been wide and varied. The first section of the book is devoted to fishing; the second to natural history. From his observations on the habits of birds, particularly the birds of his native county of Norfolk, Anthony Buxton shows that he is one of the best naturalists of the day, and he is able to describe his experiences in a vivid style that always holds the reader's attention. The photographs are very fine. We gather that some, but not all, have been taken by the author; perhaps in a subsequent edition of the book we may be told who was responsible for the others, for a fine photograph of bird or beast gains value and interest when it is known who has taken it.

The author has fished for brown trout, sea-trout and salmon in England, in Scotland and in Norway. He mentions that in Norway the best 'taking' wind for salmon is in the north-west, and I think that this holds good on Scottish rivers. Trout at times do interesting things. I quote from p. 38: "Once, on the Itchen at St. Cross, while fishing in a private garden through which one branch of the river ran, I saw a trout lying by the side of a water-lily leaf. My fly landed on the surface of the leaf, but the trout saw it land, poked its head over the top of the leaf, and picked it up."

The author on one occasion when fishing Loch Airienas in Morvern found many bumble bees lying on the still surface of the loch, and has little doubt that they were struck down by dragon flies. "I have no doubt [p. 58] that the bees on the water were runners which the dragon flies had knocked down but had not bothered or dared to pick up."

Mr. Buxton devotes one chapter to "Terriers at Fishing and other Sport". His terrier "Jane" is an expert at retrieving fish from the water, and this reminds me that a collie we once had was also a very keen fisherwoman. "Dileas" (Faithful) used to be most excited if a salmon rose in a pool which I was fishing. She twice landed a salmon. On one occasion when a Hebridean river was low, a salmon, disturbed by my appearance at a pool, left it and started down the stream for the sea, which was near. "Dileas" entered the river and brought out the salmon, one of 12 lb., clean run. On another occasion she took a salmon from the spawning beds, and when I returned the fish to the water she rushed in and brought it again to the bank; it required much persuasion to prevent her entering the water for a third time.

Chapter 5 describes a sea flood in Norfolk. This took place in the year 1938, when the sea covered an area of 7,500 acres for three months. The sea at once killed all freshwater fish in the meres and streams of this area, except eels, which flourished in the sea water. A crab was seen walking across a ploughed field, and herring, grey mullet, sprats and shrimps replaced the freshwater fish. Barnacles grew on the stems of reeds. All trees, grasses and bushes were killed. But daffodil bulbs survived (p. 109), although they remained dormant for eight years. Ash trees were killed at once, and oaks also died, but young birch (p. 112) suffered no ill-effect after three months submersion. Many birds deserted the affected area or did not nest, but yellow wagtails increased tenfold.

Mr. Buxton has made extensive observations of the Norfolk harriers from a hide. He states that the pairs of Montagu's harriers which he watched varied greatly, both in beauty of plumage and in temperament. One pair came to recognize the author and had little fear of him. There are valuable notes on the hatching of the chicks. One chick received its first meal (p. 132) only twenty minutes after birth. The photograph of the mother harrier sheltering the young with outspread wings from the sun reminds me of a similar action on the part of a female golden eagle who very gradually opened her great wings until they were fully extended, and stood thus screening her eaglet from the sun's rays.

Mr. Buxton relates that in a marsh harrier's nest (p. 138) the young birds slew and ate two weaklings of the brood. I believe that when one young golden eagle attacks and kills the other, as it often does, it may sometimes devour the victim of this unprovoked aggression. Mr. Buxton is leniently disposed towards the harriers, although they do at times take young partridges. His remarks on so-called 'vermin' (p. 149) are worth quoting: "It is a view commonly held, that if vermin is not destroyed there will be no game or other birds. Those who have travelled abroad in countries where no gamekeepers, in our sense of the word, exist, must have realised that this view is not correct. Of course the destruction by birds and beasts of prey is considerable but there is really enough for all to eat, and if there is any shortage the birds and beasts of prey betake themselves to where there is plenty."

One of the most interesting chapters in the book is that describing the courting of blackgame. A prolonged watch, extending for weeks during the nesting season, was kept from a hide near a fighting ground in Morvern, and new and valuable information on the habits of the birds gathered. The author mentions that the blackgame there have decreased: in Mull, only a few miles distant, from being numerous in 1915 they have now become almost extinct. I am glad to see that the author (p. 93) does almost all his bird watching with a telescope, as I do the same thing. It is harder to use, but I think gives a better view, at all events of larger birds, although for small birds of quick movement binoculars are preferable—but one must choose between one and the other, and a telescope is my preference.

This book is so full of good things that the reviewer is tempted to go on indefinitely. It is obviously written by one who has a deep love for Nature.

SETON GORDON

THE ENIAC, AN ELECTRONIC COMPUTING MACHINE

By Prof. D. R. HARTREE, F.R.S.
University of Manchester

Introduction

ENIAC (Electronic Numerical Integrator and Computor) is the name given to a large general-purpose calculating machine, operating by the counting of electrical pulses by electronic counting circuits, which has recently been built at the Moore School of Electrical Engineering of the University of Pennsylvania, Philadelphia. It was devised by Dr. J. Presper Eckert and Dr. John Mauchly, then of the Moore School, and was developed for the Ballistics Research Laboratory at Aberdeen Proving Ground, this development being sponsored by the U.S. War Department on the initiative of Colonel Paul N. Gillon of the Office of the Chief of Ordnance; Dr. (then Capt.) Herman H. Goldstein was closely associated with the development of the machine as representative of the Ordnance Department at the Moore School. A short article on this machine has already appeared in *Nature* (April 20, p. 527). I have recently returned from a visit to the United States in the course of which I had the privilege of working with this machine, and this fuller account is based on this experience.

Two Main Classes of Computing Equipment

Computing equipment can be divided into two main classes. Devices of one class operate by translating numbers into physical quantities (for example, lengths, angular rotations, voltages, light fluxes) of which the numbers are the measures, operating with these quantities (such as with angular rotations through gear trains, with voltages through electrical circuits) and finally measuring some physical quantity to obtain the answer; examples are the slide rule, the differential analyser[1] and the heat flow computor of Beuken and of Paschkis and Baker[2]. Those of the other class handle numbers directly in digital form and, usually, operate by counting discrete events of some kind; examples are the ordinary desk calculating machines such as the Brunsviga, Marchant and Fridén. I have found it convenient to distinguish the two classes by the terms 'instruments' and 'machines' respectively; the American usage is 'analogue' and 'digital' machines.

Devices of the former class may be able to handle continuously varying quantities, but their accuracy is limited by the attainable accuracy of physical measurement, and of the mechanical and electrical components of which they are built up. Devices of the second class are necessarily restricted to handling numbers which can be expressed in finite digital form; thus they cannot directly handle continuously varying quantities but, with that restriction, they can in principle be built to work to any required finite degree of accuracy.

The ENIAC is of the second class. It carries out by electronic circuits the processes of arithmetic, of which discrimination of the sign of a number and judgment of the equality of two numbers must be added to the usually recognized processes of addition, subtraction, multiplication, and division. Integration has to be replaced, as is usual in numerical work, by summation over a finite number of finite intervals. The machine was built primarily for integration of the equations of external ballistics by such a step-by-step process; but its organisation is flexible enough for it to be applicable to a wide range of large-scale computations other than numerical integration of differential equations.

Arithmetical Processes, 'Memory', and Organisation

The purpose of the ENIAC is to carry out extended computation automatically, or with only occasional attention from a human operator. Both for this reason and to make full use of the high speed at which the machine carries out individual arithmetical operations, it is necessary first that the sequence of individual operations should be furnished to the machine in such a form that it can be followed automatically, and at a speed comparable with the speed of carrying out individual arithmetical operations; and secondly, that the machine should be able to record and retain intermediate results of the calculation in such a form that they can be both recorded and read in times comparable with the times occupied by arithmetical processes.

Thus, as well as equipment for carrying out the arithmetical operations, the machine requires a means of organising the sequence of these operations, and a 'memory' for the numbers on which these operations are to be performed and for the results of these operations. These two aspects of a large high-speed calculating machine are at least as important as the means of carrying out the arithmetical processes themselves. The range of computing problems to which a machine of this kind can be effectively applied depends critically on the high-speed memory capacity which the machine provides, and one of the problems for future general-purpose machines is to provide adequate capacity without requiring excessive amounts of equipment.

General Construction of the ENIAC

The ENIAC consists of a number of units for carrying out the various operations which may be required in an extended computing problem, such as addition, multiplication, division, input (that is, reception of numerical data from the outside world), output (that is, provision of numerical results to the outside world) and organisation of the sequence of the computation. Interconnexions between these units can be set up in different ways through plug-and-socket connexions and switch settings, and these connexions and settings, which are made by hand, form the 'set-up' of the machine for any particular computation.

Each unit consists of an assembly of electronic valves, switches, relays, indicating lamps, and plug sockets, mounted on one or more panels about 8 ft. high and 2 ft. wide and permanently connected with the switches, indicating lamps, and plug sockets in front and the valves, relays, and associated equipment at the back. There are altogether forty of these panels arranged around three sides of a room; Fig. 1 shows a general view of the machine, Fig. 2 a closer view of the front of the first six panels on the left-hand side of Fig. 1, and Fig. 3 a close-up view of the front of two adjacent panels.

The various units are interconnected through two sets of coaxial lines carried in 'trays' running round the length of the machine, one set (*a* in Figs. 2 and 3) called 'digit trays' for carrying pulse groups representing numerical data from one unit to another, and

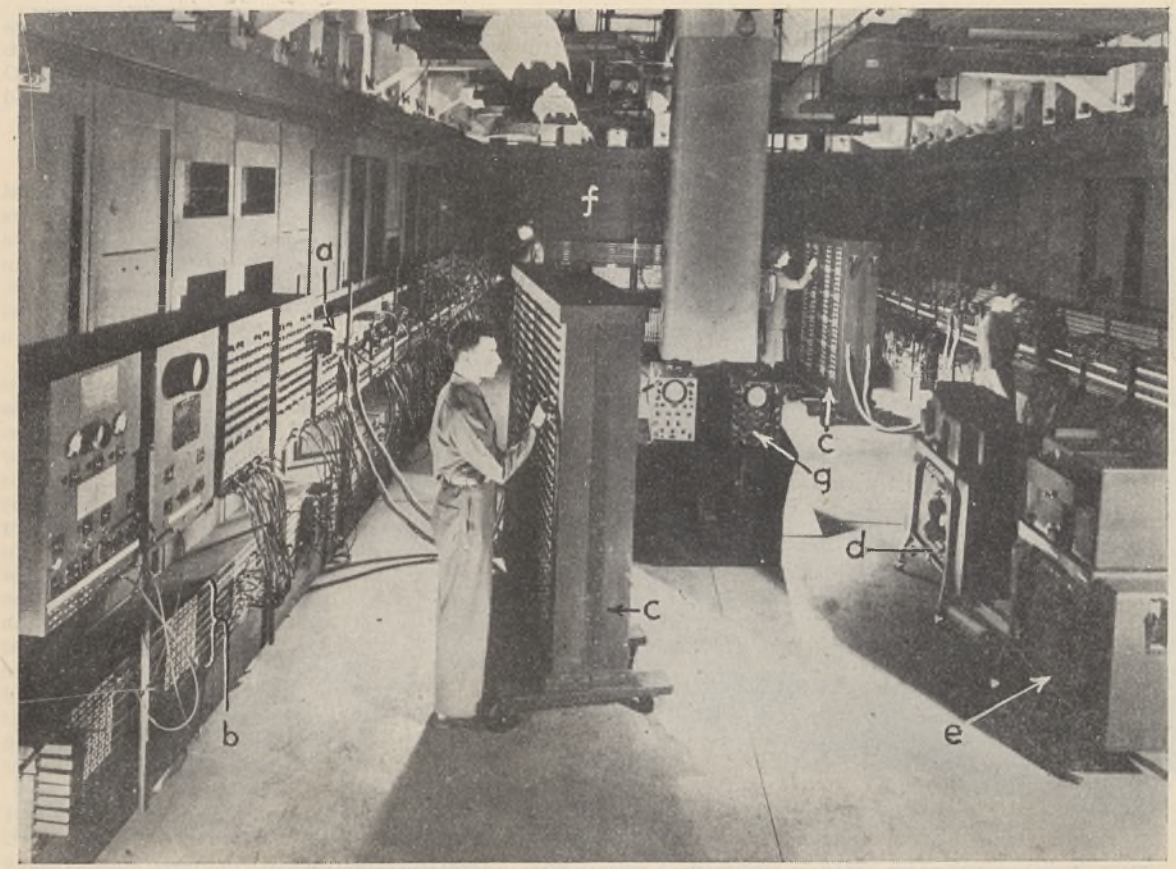

Fig. 1. GENERAL VIEW OF THE ENIAC. *a*, DIGIT TRAYS (SEE FIG. 2); *b*, PROGRAM TRAYS (SEE FIG. 2); *c*, FUNCTION UNIT (SEE FIG. 2); *d*, CARD READER; *e*, CARD PUNCH; *f*, HIGH-SPEED MULTIPLIER; *g*, TESTING EQUIPMENT

the other (*b* in Figs. 2 and 3) called 'program trays' for carrying pulses controlling the sequence of operations of the different units, which can be plugged into the trays in accordance with the set-up for any particular computation. The units are also permanently connected to a set of lines which are supplied with a standard pattern of pulses from a pulse-generator. Individual pulses used for numerical purposes are spaced at 10 microsec. interval, and the whole pattern of pulses is repeated every 200 microsec.; this is the time taken to carry out an addition on the machine, and is the natural unit of time in which to express its performance; it is called an 'addition time'.

The machine works with numbers expressed in the decimal scale, to ten decimal digits, and with each number there is also an indication of its sign. Pulse groups representing the digits of a single number are transmitted simultaneously on different lines, requiring eleven lines in each digit tray for the ten decimal digits and sign (the twelfth terminal, which can be seen in Fig. 3 on the digit tray sockets, is for an earth connexion).

The 'program trays' have the same construction as the digit trays, but in their use each line is used independently of the others, so that a single tray carries eleven distinct 'program lines' for the transmission of pulses controlling the operation of the various units.

In the counting and control circuits, all valves are used entirely as on-off elements, not as amplitude-sensitive elements, and the circuits have been designed to operate satisfactorily with wide tolerances on valve characteristics, applied potentials, pulse frequency, etc. To avoid replacement difficulties only standard valves are used, and these are run at conservative ratings.

Accumulators

The basic units of the ENIAC are the 'accumulators' (see Fig. 3), each of which is analogous to a register of a multi-register adding machine such as the "National", and combines the functions of an adding unit and a memory unit.

The numerical portion of each accumulator consists of ten decade counters, one for each decimal place, a decade counter consisting of ten double-triode valves in a ring. Each of these valves has a 'normal' and an 'excited' state, and the connexions of the counting ring are such that at any time only one valve of the ring is in the excited state, and that the reception of a single pulse steps the excitation from one valve of the ring to the next. There are auxiliary valves for controlling carry-over from one decade to the next, for transmission of the number represented by the excited valve in each decade, for clearing, etc. Transmission is effected by cycling each decade by supplying it with ten pulses, carry-over from one decade to the next being suppressed; if the excited valve in a decade represents the number n, then either n or $9-n$ of the ten pulses can be transmitted, depending on the setting of a switch; thus either a number held in an accumulator or its complement can be transmitted. The counting rings count only

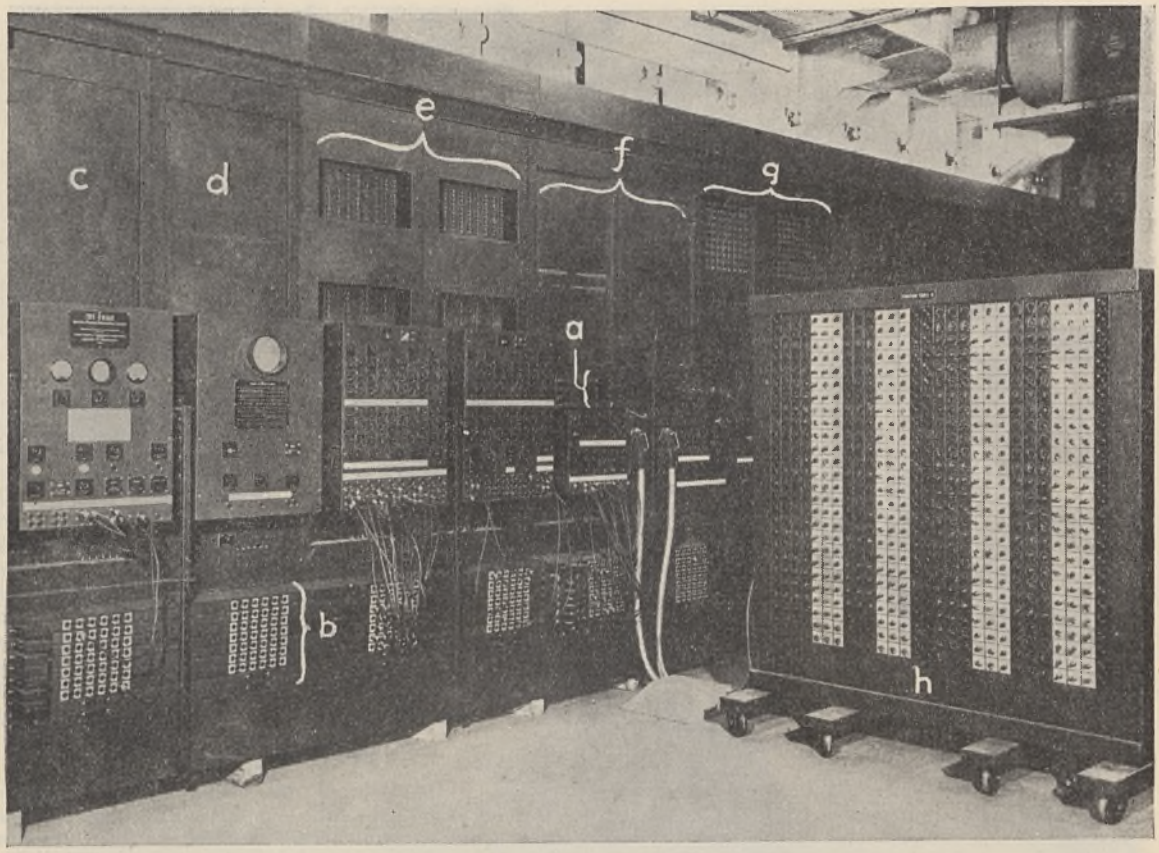

Fig. 2. LEFT-HAND SIDE OF THE ENIAC. *a*, DIGIT TRAYS ; *b*, PROGRAM TRAYS ; *c*, INITIATING UNIT PANEL (INITIATING PULSE, CONTROLS FOR CARD READER AND CARD PUNCH) ; *d*, PULSE GENERATOR PANEL ; *e*, MASTER PROGRAMMER PANELS ; *f*, PANELS FOR FUNCTION TABLE (*h*) ; *g*, PANELS OF ACCUMULATORS 1 AND 2 ; *h*, FUNCTION TABLE

in one direction, and subtraction is effected by addition of the complement. The number held by an accumulator, that is, the number represented by the excited valves in its ten decades and sign register, is indicated on the front of the panel by means of indicating lamps (Fig. 3, *e*).

Each accumulator has two channels for the transmission and five for the reception of numerical information ; each of these channels can be connected to any digit tray by plugging in a short length of 12-wire cable to sockets on the accumulator and digit tray (see Fig. 3, *f*). On one of the transmission channels the accumulator can transmit the number it holds (additive output), and on the other the complement of this number (subtractive output) ; these can be used simultaneously, but if so must be connected to different digit trays. In the connexion from a digit tray to a reception channel there can be interposed a 'shifter' by which the p-th decade from the right in the transmitting accumulator is connected to the $(p + n)$-th decade in the receiving accumulator ; shifters with connexions giving various positive and negative values of n are available, and serve for multiplication by powers of 10. Through its five reception channels an accumulator can be connected to different digit trays, or to a single digit tray both directly and through one or more shifters. Only one reception channel can be used at once.

The normal state of an accumulator is quiescent, holding the number which resulted from its last operation. It has twelve program channels through which it can be stimulated by a pulse from a program line, this pulse being transmitted by one of the units involved in the next previous operation in the computing sequence, as soon as this operation is completed. What the accumulator does when so stimulated, that is whether it transmits additively or subtractively or both, and holds or clears after transmission, or receives, and if so on which channel, is determined by the settings of switches, of which there are two for each program channel on each accumulator (see Fig 3, *c*). Further, on eight of the program channels there are repeat switches (see Fig. 3, *d*), by which the accumulator can be set to repeat the operation of transmitting or receiving any number of times from 1 to 9. On each of these same eight program channels, the accumulator can transmit a pulse to a program line when the complete operation (including any repeats) indicated by the switch settings is completed. This pulse then stimulates the units concerned in the next operation of the computing sequence.

In the transfer of a number from one accumulator to one or more others, both or all accumulators involved, and no others, have to be stimulated simultaneously ; this is done by connecting one input program channel on each of the accumulators concerned, and no others, to a single program line. Since neither transmission nor reception can take place unless stimulated by a program pulse, a number of transmission and reception channels from a number of accumulators can be connected to the same digit tray, which will be concerned at different times with transfers between different members of this set of

accumulators, those involved at any time being determined by the connexions to the program lines. On the other hand, simultaneous transfers can take place by connexions through different digit trays.

Multiplier

Multiplication by small integers (1 to 9) can be carried out by repeated addition by use of repeat switches, provided the values of these multipliers is known before the calculation is started. But for multiplication by numbers of several digits the process of successive addition is a long one, and multiplication is so frequent an operation in most computations that a quicker means of carrying it out is desirable.

The ENIAC has a high-speed multiplying unit which uses an array of electronic valves so connected as to form a built-in multiplication table up to 9×9; using this, the result of the multiplication of the whole multiplicand by each digit of the multiplier is carried out in one addition time. The left-hand and right-hand figures of each product of a digit of the multiplicand and a digit of the multiplier are accumulated separately to form two 'partial products', which are finally combined to form the product. For an m-digit multiplier the whole process takes $(m + 4)$ addition times instead of an average of $4\frac{1}{2}m$ addition times required for multiplication by continued addition. Not only is the saving of time important, but the fact that multiplication does take a definite time at all, and not a time depending on the particular digits of the multiplier, is important in the organisation of the computing process in any particular case.

The time taken for the multiplication of two 10-figure numbers is just under 3 millisec. Normally the multiplier is connected to give a 10-figure product without carry-over from the eleventh place; four accumulators are involved in such a multiplication, two for holding the factors to be multiplied, and two for accumulating the partial products. But it can be arranged to give the full 20-figure product; this involves the use of six accumulators. The circuits special to the multiplier take three whole panels (Fig. 1, *f*).

The multiplier has twenty-four program channels, with each of which is associated a group of switches on which are set the reception channels through which the numerical values of the factors to be multiplied are to be received, whether these are to be held or cleared after the multiplication is completed, the disposal of the product, the number of figures to be used in the multiplicand, and the number of figures to be retained in the product.

Divider and Square-rooter

There is also a unit for carrying out division and extraction of square roots. Division is carried out by a process of successive subtraction, the sign of the partial remainder being tested after each subtraction. The divider is first subtracted from the dividend until the sign of the remainder becomes negative; the remainder is then multiplied by 10 and the divisor added until the remainder becomes positive, and so on; count is kept, in an accumulator serving as quotient register, of the number of times the divisor is added and subtracted in the successive decimal places. This is a comparatively slow process; determination of an m-figure quotient takes on the average $13m$ addition times. But most computations can be so arranged that division is a comparatively rare operation, and it is not important to use a more rapid process for it.

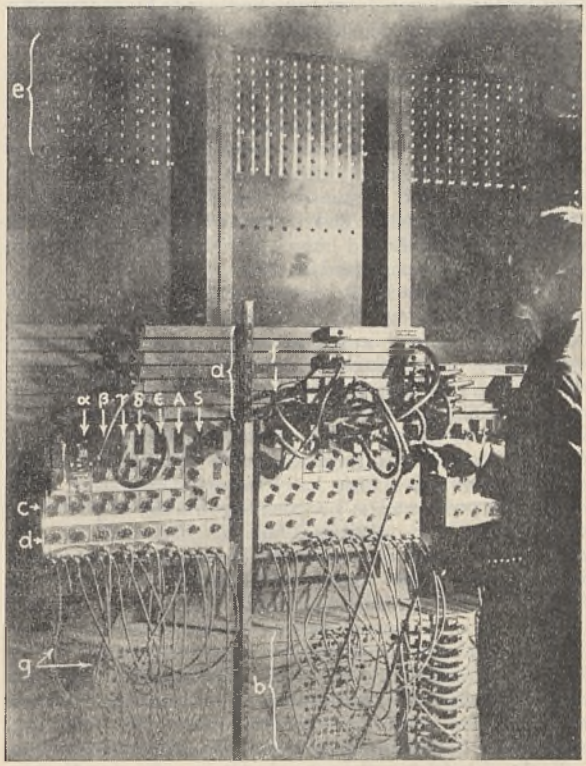

Fig. 3. FRONT VIEW OF ACCUMULATORS. *a*, DIGIT TRAYS; *b*, PROGRAM TRAYS; *c*, OPERATION SWITCHES; *d*, REPEAT SWITCHES; *e*, INDICATOR LAMPS; *f*, CONNECTING CABLES BETWEEN DIGIT TRAYS AND ACCUMULATORS; *g*, CONNECTING CABLES BETWEEN PROGRAM TRAYS AND ACCUMULATORS. α, β, γ, δ, ε, TERMINALS OF ACCUMULATOR CHANNELS FOR RECEPTION OF NUMERICAL INFORMATION; *A*, *S*, TERMINALS OF ACCUMULATOR CHANNELS FOR TRANSMISSION OF NUMERICAL INFORMATION

Extraction of a square root is carried out by a similar process, which can be regarded as division by a variable divisor.

Since both these processes are slow, it is often advisable to carry out other steps of the computation in parallel with them if this can be done without conflict in the demands on the use of digit trays. Since the time occupied by a division cannot be determined in advance, it is necessary when this is done to have an interlock circuit so that a program pulse is not given out until both the division and the parallel program have been completed.

Function Tables, Input and Output Equipment

The ENIAC has three function tables (see Figs. 1, *c* and 2, *h*), each of which comprises an array of switches on which 6-figure values of two functions, with signs, or a 12-figure value of one function, can be set up for each of 104 values of an argument. These switches are connected up so that for any two-figure argument x from 00 to 99, input to the function table, the value of the function for that argument is output in the form of pulse groups on the appropriate digit lines. Also, if required, the values of the function for arguments $x \pm 1$ and also for $x \pm 2$ can be output for use in interpolation formulæ, the choice of which set of function values to take being determined by the setting of a switch, and the corresponding interpolation formula being set up by interconnexions of the multiplier, function table, and accumulators.

The ENIAC has also a 'constant transmitter' which has eight 10-figure relay registers to which numbers

can be transferred from punched cards by means of a card reader (Fig. 1, *d*), and two 10-figure registers on which numbers can be set by hand switches; each of these ten registers can be used in two halves to give two 5-figure numbers if required. Each register has three program channels and on stimulation by a pulse on any of these, it transmits the number it holds to the common output channel of the constant transmitter, and thence to the digit tray to which this is connected. The accumulator to which this number is transferred has to be stimulated to receive on a channel connected to this digit tray.

The numbers held in the relay registers can be changed in the course of a computation by stimulating the reader to feed and read a new card; this is done by means of a program pulse to the reader itself. This is a comparatively slow process, and if any arithmetical operations are carried out in parallel, an interlock is necessary as on the divider.

Results are output in the form of punched cards, the card punch (Fig. 1, *e*) being stimulated by a program pulse at the proper stage in the sequence of operations. In addition, the machine can at any time be stopped, and the numbers held by the accumulators read by visual inspection of the indicating lamps associated with the counting decades. By the operation of a control switch, the machine can be set so that at each pressure of a push-button, the set of pulses emitted by the pulse generator in just one addition-time only is supplied to all units, so that the process of a computation addition-time by addition-time can be watched in detail by inspection of the numbers held by the accumulators after each time the push-button is pressed. This is most valuable in checking and in locating faults.

Master Programmer

The number of individual computing operations in any extended computation is much greater than the total number of program channels of all the units of the ENIAC, so that if each single operation had to be set up separately the capacity of the machine would be severely restricted. However, most extended computations involve the repetition of a basic sequence of computing operations, applied successively to different sets of numbers, though there may be breaks in the regular repetition of the sequence, either at predetermined points or at points depending on the results of the computation. For example, in the step-by-step numerical integration of a system of simultaneous ordinary differential equations, the basic sequence is the integration procedure for one interval of the integration, which is a sequence of operations starting from the initial values for that interval and giving final values which become the initial values for the next interval. In the course of such an integration, it may be required to break the exact repetition of the procedure by changing the interval-length, either at predetermined values of the independent variable, or at values to be determined by the behaviour of the solution. Evaluation of a formula for various values of the argument, and iterative calculations, are other examples of computations involving repetition of a basic computing sequence.

For purely repetitive calculations it is sufficient to set up the machine for the basic computing sequence, *and* for the step from the ending of one repeat of this sequence to the beginning of the next. For calculations which do, or may, involve departures from strict repetition of a basic computing sequence, means of carrying out these departures is required.

A most important unit of the ENIAC from the point of view of the organisation of a computation is that called the 'master programmer' (see Fig. 2, *e*), which handles automatically the repetition of a computing sequence and the change from one computing sequence to another, either at predetermined stages in the computation or at stages depending on some criterion (usually the sign of some number) applied in the course of the calculation.

The 'master programmer' operates by switching program pulses from one program line to another. It consists of ten six-position electronic switches called 'steppers', with each of which a counter can be associated. Each stepper has four input channels. and one output channel for each of its six switch positions. A pulse received on the 'normal input' channel gives rise to a pulse on the output channel corresponding to the switch position of the stepper, so that by connecting two or more of these output channels to different program lines, different computing sequences can be initiated by a program pulse on a single line, according to the switch position of the stepper. The counter, if used, normally counts pulses received on the normal input channel, but the number registered by it can also be advanced by pulses on a 'counter direct input' without giving any output pulses; the counter is reset to zero when the stepper moves from one switch position to another.

A stepper can be stepped from one switch position to the next in two ways: first, automatically when the number registered by the counter associated with it has reached a prescribed value previously set on a group of switches; secondly, by a pulse applied to the 'stepper direct input' channel. It can also be cleared back to its first position in two ways: first, by a pulse applied to the 'stepper clear' input channel; and secondly, an auxiliary switch can be set so that any chosen number q from 2 to 6 of the switch positions of the stepper are operative; the stepper is then cleared by a stepping pulse received when in its q-th position.

To repeat a computing sequence, the normal input channel of a stepper is connected to the program line which receives a pulse from one of the units involved in the last step of a computing sequence, and one of the output channels of the stepper is connected to the program line on which a pulse stimulates the units involved in the first step of the sequence. Then so long as the stepper is in the switch position corresponding to this output channel, the computing sequence forms a ring of operations closed through the master programmer. A starting pulse supplied to the program line connected to the normal input of the stepper will then start the computing sequence, which will be repeated so long as the switch position of the stepper remains unaltered.

Use of the counter associated with a stepper enables the computing sequence to be changed after a predetermined number of repeats. Use of the stepper direct input enables it to be changed according to some criterion applied in the course of the calculation. This criterion is often the sign of a number occurring in the work, or of the difference between two numbers. Use of such a criterion involves taking pulses from a numerical transmission channel to a program line; this requires the use of a special adapter, but otherwise offers no difficulty.

The number of steppers available in the master programmer, and the possibility of interconnecting

them with one another as well as with the part of the machine concerned with the arithmetical work, introduces a very considerable degree of flexibility into the ENIAC, and makes possible its automatic application to problems involving a considerable degree of discrimination and judgment. But it must be clearly understood that the situations requiring this judgment, and decision as to what action is to be taken in them, must be fully anticipated in the setting up of the machine. It can only do precisely what it is told to do; the decisions on what to tell it to do, and the thought which lies behind these decisions, have to be taken by those who are operating it. Use of the machine is no substitute for the thought of organising the computations, only for the labour of carrying them out.

Set-up and Use

In applying the ENIAC to any particular computation, it is necessary first to break down the work into a number of basic computing sequences, the ordering of which is controlled by the master programmer, and then to break down each sequence into the individual computing operations of which it is composed, which are carried out through the interconnexions of the arithmetical units of the machine.

In planning the organisation of calculations other than that of trajectories for which the machine was primarily designed, the main restriction found has been the small memory capacity into which numbers can be recorded, and from which they can be read automatically, in times of the order of a few addition times. This memory capacity consists of the twenty accumulators, but as four of these have assigned uses in any multiplication and another four in any division, not more than sixteen, and often fewer, can be regarded as available for storing intermediate results. This capacity is adequate for the original purpose of the machine, but for other and more extended computations it is often found that the method of calculation used is determined primarily by this question of memory capacity rather than by any other considerations.

The machine has an indefinitely large memory capacity in the form of punched cards, but both recording into and reading from this memory is comparatively slow—of the order of two or three thousand addition-times—and, further, its use for intermediate results which are required later in the calculation requires the attention of an operator to transfer cards from the punch to the reader. Thus although this use of punched-card memory greatly increases the power and range of the machine, it does so at the expense of the speed and fully automatic character of its operation.

However, powerful use can be made of the ENIAC in conjunction with punched-card equipment in other ways, particularly by means of the reproducing punch and the sorter. By means of these, results obtained as decks of punched cards in one set of calculations on the ENIAC can be rearranged on to other decks of cards in a convenient way to be used as input data to the card reader of the ENIAC in subsequent calculations. The scope and power of this use of the ENIAC and punched-card equipment in combination promises to be considerable.

Examples

The speed and power of the ENIAC can best be illustrated by examples. Its speed is so much greater than that of any other existing computing equipment that it is not easy to realize without some experience of the machine.

Multiplication is a so much slower process than addition, and division so comparatively rare, that the total time of a computation not involving large numbers of readings or punchings of cards can be estimated from the number of multiplications involved. A multiplication takes rather less than 3 millisec., so that a computation involving altogether ten million multiplications would take about 30,000 sec., or about $8\frac{1}{2}$ hours, and is therefore quite within the range of practical possibility, provided, of course, that this large number of multiplications arises from a large number of repetitions of a fairly short basic computing sequence and that the number of intermediate results to be remembered at any time is not beyond the capacity of the machine. Numbers of arithmetical operations of this order of magnitude are quite likely to be required now that equipment for handling numbers on this scale is available, though in several contexts, for example, evaluation of solutions of partial differential equations in three variables, or solution of large numbers of simultaneous algebraic equations, the memory capacity required is likely to be more than that available on the ENIAC without using cards.

An example of the speed and capability of the ENIAC is provided by a problem on which I used it while working at the Moore School. This was concerned with the solution of three simultaneous non-linear ordinary differential equations which arise in the theory of the laminar boundary layer in a compressible fluid. These equations are of the form $f' = h/[1 + \alpha r]^{1/9}$; $h'' = -fh'$; $\beta r'' + (h')^2 = -fr'$; ($\alpha$ and β being constants) with the two-point boundary conditions

$$f = h = r' = 0 \text{ at } x = 0$$
$$h = 2, r = 0 \text{ at } x = 5,$$

(the conditions $h = 2$, $r = 0$ are actually conditions at $x = \infty$, but it was known that to the 6-figure accuracy aimed at they could be replaced by conditions at $x = 5$). Solutions were required for each of a set of values of α. The awkward nature of the boundary conditions, rather than the form of the equations, is what makes the application of the machine so impressive.

The boundary conditions were satisfied by running trial solutions with different trial values of $h'(0)$ and $r(0)$ and adjusting these until the conditions at $x = 5$ were satisfied to 7-figure accuracy, no results being punched except initial and final values for each run. Approximate values for the variation of $h(5)$ and $r(5)$ with $h'(0)$ and $r(0)$ were available, and it was possible, by using the master programmer to switch from one computing sequence to another, to arrange that from any one set of values of $h'(0)$, $r(0)$, $h(5)$ and $r(5)$ the machine determined better values of $h'(0)$, $r(0)$, and continued this process of alternately evaluating a solution and determining better initial conditions from the results until a criterion was satisfied, after which a final solution was made, the values of f, h', h, r', r then being punched for every integration interval.

To avoid considerable demands on memory capacity, it was considered best to use a rather simple integration formula, and therefore small intervals of integration. Intervals $x = 0{\cdot}02$ were used, so that 250 intervals were required to cover the range $x = 0$ to 5. The integration was carried out at the

rate of about eight intervals a *second*, a single trial solution taking about half a minute. The final run, punching a card for every interval of the integration, took about 2½ minutes.

Thus once the ENIAC had been set up and provided with initial estimates of $h'(0)$ and $r(0)$, it carried out without further attention from an operator the determination to 7-figure accuracy of the values of these two quantities for which the solution satisfied the conditions at $x = 5$, and evaluated and punched 250 values of the final solution. The total time taken depended on the number of trial solutions required, but was about four minutes for each value of α.

A fuller account of this work is in course of preparation.

Acknowledgments

I wish to express my thanks to Colonel P. N. Gillon for making the arrangements which enabled me to obtain first-hand experience of the ENIAC and its use, to Dr. L. S. Dederick of the Ballistics Research Laboratory for agreeing to make the machine available for the work referred to in the section above, and to Dr. and Mrs. H. H. Goldstein and to members of the group operating the ENIAC, particularly Dr. D. H. Lehmer and Miss K. McNulty, for information, advice and help in setting up and operating the machine on this work.

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[2] Beuken, L., *Econ. Tech. Tijdschrift* (Maastricht) ige jaarg., 43 (1939); Paschkis, V., and Baker, H. D., *Heat Treatment and Forging*, **27**, 375 (1941), and *Trans. Amer. Soc. Mech. Eng.*, **64**, 105 (1942). See also Jackson, R., and others, *J. Iron and Steel Inst.*, Part II of 1944, p. 211.

JUBILEE OF THE MARINE BIOLOGICAL STATION, MILLPORT

By Prof. C. M. YONGE, F.R.S.

Chairman, Executive Committee, Scottish Marine Biological Association

On October 17, 1896, the foundation stone was laid, by Dr. Thomas Reid, of the first building of the Marine Biological Station at Millport. The fiftieth anniversary of this important date in the history of marine biology in Scotland most happily coincides with the first joint meeting of the Challenger Society to be held at a marine station since the end of hostilities. Visitors to that meeting will see a laboratory greatly extended by buildings erected immediately before the outbreak of war and others acquired more recently. These make possible considerable increases to the staff and programme of the station.

The Millport laboratory has a dual origin. It came into being through the combined efforts of Dr. David Robertson, the "Naturalist of Cumbrae", whose life, under that title, was written by his friend, the Rev. T. R. R. Stebbing, and of Dr. (later Sir) John Murray. Thus, through Murray, the Station can trace its history back to the *Challenger* office and so to the expedition. In 1884, largely as a result of his efforts, a Scottish Marine Station was established in the Firth of Forth. In a submerged quarry at Granton was moored the *Ark*, an old lighter on which was built a wooden laboratory, while sea work was carried out from Murray's steam yacht, the *Medusa*. In the summer of the following year both vessels were taken through the Forth and Clyde Canal to Millport. Murray's intention had been to move about the west coast of Scotland; but the presence of Robertson at Millport and its excellent position as a centre for work in the Clyde sea area induced him to establish the laboratory permanently on the Island of Cumbrae. Eventually the *Ark* was drawn up on the shore near Farland Point on the east side of Kames Bay, where she remained in continuous use until destroyed in a great storm on December 20, 1900.

This early period of marine work at Millport saw the production by Murray and H. R. Mill of a notable series of papers on the configuration and physical conditions with special reference to marine life in the Clyde sea area. When this work was finished, the *Medusa* returned to the east coast, but the *Ark* remained at Millport and became to a large extent the personal laboratory of Dr. Robertson until, in 1894, it was lent to a committee formed for the purpose of establishing a marine biological station at Millport. During the following three years no less than thirty-one persons, among them E. W. MacBride, Robert Broom and J. F. Gemmill, the last to be intimately associated with the station for many years, worked in this simple but effective laboratory.

The foundation of a permanent station followed quickly. Dr. Robertson cut the first sod on August 7, 1896, but was too ill to attend the laying of the foundation stone in October and died on November 20. The buildings were opened, appropriately by Murray, on May 17, 1897. In 1901 the title of the controlling body was changed to the Marine Biological Association of the West of Scotland and so remained until 1914, when it assumed its present title of the Scottish Marine Biological Association.

The original building contained living accommodation for the curator (this now forms the office and two small research rooms) and a laboratory divided into cubicles, with a tank room and an engine room behind. Above were housed the Robertson Museum, presented by Mrs. Robertson, and behind it the library. The *Ark* continued in use until its destruction. Work at sea was carried out from the *Mermaid*, a wooden steam yacht 65 ft. long. In 1904 the present director's house was built and the laboratory extended by the erection of a wing, at right angles to the original block, which houses the aquarium below and a class-room above. The buildings remained in essentially this condition until 1939.

The period 1905–14 was one of considerable difficulty, and for a while the fate of the Station hung in the balance. The first scientific director, S. Pace, left in 1907 and was succeeded as superintendent by the present director, Mr. R. Elmhirst, who had been appointed naturalist the previous year and who thus now completes forty years of service. Generations of students, among whom the writer is glad to include himself, have had their first instruction in marine biology from him, and there is little doubt that without his cheerful optimism and persistence in difficult days the Millport Marine Station would not exist to-day. Reference must also be made to the services of Mr. John Peden, appointed laboratory assistant in 1906 and still happily in the employment of the Laboratory, who maintained it during the period of

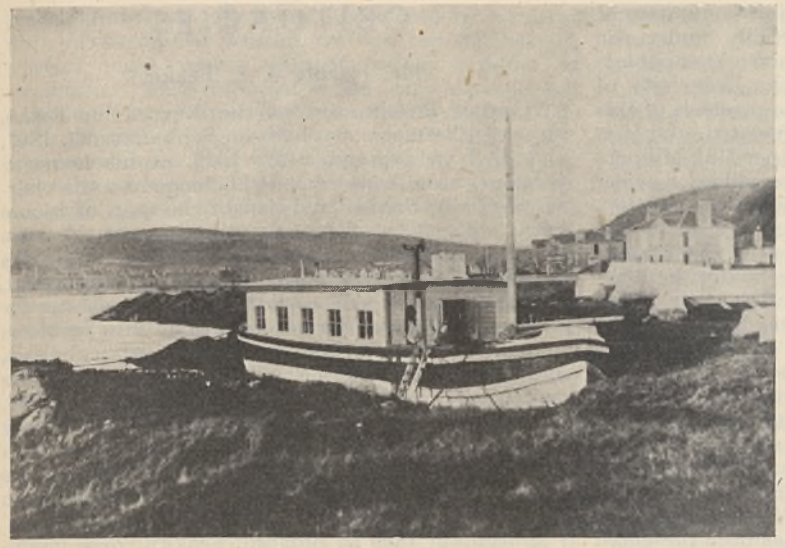

Fig. 1. THE *Ark* DRAWN UP AT FARLAND POINT, MILLPORT

the First World War when Mr. Elmhirst was on war service.

The modern period of expansion may be said to date from 1921 when the Association first received financial help from the Development Commission. The staff was enlarged by the appointment of Dr. Sheina M. Marshall and Dr. A. P. Orr, whose joint work on plankton and the physico-chemical conditions in the sea have become part of the fundamental literature of marine biology and gained the Millport Laboratory international recognition as a centre of fundamental research. They were joined later by Dr. A. G. Nicholls, now in Western Australia, and work was extended to the biology of young herring. Meanwhile important faunistic and ecological work was carried out on the inter-tidal fauna by the director and many visiting workers, among whom may be mentioned Dr. A. C. Stephen and Dr. E. E. Watkin. Dr. Nicholls explored the newly discovered fauna of sand-living copepods. The rich and easily available supply of echinoderms and the purity of the surrounding sea water were utilized especially by Prof. J. Gray, Dr. G. S. Carter and Lord Rothschild in studies on the physiology of fertilization. A general account of the activities of these years has been given by the director in a short account of "Marine Biology in the Firth of Clyde" (*Scottish Naturalist*, July–August 1939), while in the annual report of the Association for 1938–39 he gave a bibliography of publications dealing with work carried out at the Station from April 1897 to March 1939, which comprises 292 titles.

This period of expansion owes much to the activities of Prof. L. A. L. King, Prof. F. O. Bower and especially Prof. (now Sir John) Graham Kerr, who was chairman of the Executive Committee until his resignation from the regius chair of zoology in the University of Glasgow in 1935. His successor, Prof. E. Hindle, will similarly be remembered with gratitude for the energy and success with which he pressed forward the schemes for expansion which culminated in the erection, parallel to the original block, of a fine modern wing which was opened in June 1939. This contains on the ground floor a tank room, a receiving room and six work rooms; on the floor above a class-room for advanced students, a specimen store, a dark room, a chemical laboratory, and a balance room, and four work rooms. By converting the cubicles in the old building into a museum, the original museum has been cleared and is now a spacious and well-fitted library, the contents of which are being rapidly increased.

During the Second World War the Station suffered a great loss in the death in action of Mr. W. N. Paton, who had succeeded Dr. Nicholls and was a marine biologist of the highest promise. His place has recently been filled by the appointment of Dr. R. B. Pike. Dr. Marshall and Dr. Orr did important national service by working out methods of extraction and preparation of agar from the British red sea weeds, *Gigartina* and *Chondrus*, and by surveying large areas of the Scottish coasts for supplies of these algæ. Their methods have now been developed industrially and represent an important contribution from marine biology to British commercial enterprise. In addition, these members of staff collaborated in experiments initiated from the University of Edinburgh on the effects of artificial enrichment by nutrient salts in sea lochs on the Argyll coast.

The enlarged premises of the Station have been fully utilized by the presence since 1941 of a team of workers engaged on research into anti-fouling

Fig. 2. THE MARINE BIOLOGICAL STATION, MILLPORT, IN 1946. THE NEW WING, COMPLETED IN 1939, IS SHOWN ON THE LEFT; THE EX-ADMIRALTY BUILDINGS LIE ACROSS THE ROAD IN FRONT OF THE STATION

measures for the Marine Corrosion Sub-Committee of the Iron and Steel Institute, initially under the direction of Dr. J. E. Harris and, since his appointment to the chair of zoology in the University of Bristol, by Mr. K. A. Pyefinch. The presence of this active team has been greatly appreciated, and it is hoped that this work will be continued at Millport for many years. Difficulties of space will arise owing to forthcoming increases in the staff of the Station, but fortunately a series of buildings erected by the Admiralty across the road in front of the Station have been acquired (the cost being kindly defrayed by an anonymous donor) and, after appropriate alterations have been made, it is intended to transfer the anti-fouling team to the largest of these premises until separate buildings for their use can be put up.

The Millport Laboratory is thus in fortunate possession of adequate modern buildings and of a small but highly efficient scientific staff. A comprehensive programme of research involving a considerable increase in staff and the acquisition of a larger boat in place of the *Nautilus*, the 39-ft. motor vessel which has been in use since 1922, has been presented to the Development Commission. Two new members of staff, a zoologist and a chemist, are being appointed immediately, and it is hoped to raise the staff to a total of ten within the next few years. Hitherto confined to the Clyde sea area, the activities of the station are now to be extended along the west coast of Scotland, and this summer two parties of workers have been engaged along the coast of Argyll, one in Loch Sween, where a mobile laboratory is in use, and the other at Easdale. Both have been concerned with the possibilities of breeding and farming oysters. For the first time this summer the *Nautilus* passed through the Crinan Canal and carried out dredging operations in Loch Sween and West Loch Tarbert—a notable event in the history of the Station. But the larger boat will be necessary to take full advantage of the rich possibilities for marine research in these waters, the fauna of which may, in the deeper areas, some of which are exposed to the scouring action of powerful tidal currents, prove to be as rich as that of the Norwegian fjords.

A far-reaching programme of research on the plankton community will, with the advent of new members of staff, be initiated next year, and the fundamental research on which the reputation of the Station has been established will thus be extended. Increasing attention is being paid to the adaptations and ecology of bottom-living and shore animals, especially the former, which provide the link between the plankton and demersal fish. Other projects include further work on herring, investigation into the life-history and migrations of the scallop (*Pecten maximus*) and the running of an experimental lobster hatchery on the American pattern to determine whether the larvæ of the European species can be as successfully reared to the bottom-living, lobsterling stage as can those of *Homarus americanus*.

The Scottish Marine Biological Association looks forward to a future of ever-increasing activity over a wide area of the most diversely varied coast around the British Isles. It aims at providing the essential background of pure research to the manifold activities of the Scottish marine industries in particular and to those of Great Britain and Western Europe in general. At the same time it offers greatly enhanced facilities for teaching and especially for the carrying out of original research in all branches of marine biology, including physiology and algology.

OBITUARIES

Mr. Harold J. E. Peake

HAROLD PEAKE, son of the Rev. John Peake, vicar of Ellesmere, was born on September 29, 1867, and died on September 22, 1946, at his home at Boxford, near Newbury. He belonged to the characteristically British tradition of the man of leisure who, without professional commitments, devotes himself to intellectual and public work. One thinks of Charles Darwin and Francis Galton, among others, in this connexion. An early training at Leicester for estate management gave Peake insight into problems of land tenure and land use on a historical basis, and resulted later on in a valuable study of old roads (published in "Memorials of Old Leicestershire"). In 1897 he married Miss Charlotte Bayliff and they went round the world, staying some time on a ranch in British Columbia, from the life of which Peake gained clues to his later interpretations of pastoralism in prehistoric times.

Settling in 1899 at Boxford, Peake's house gradually became a centre of light and leading not only for the Newbury district but also for many students of humanity, including younger men whom he helped with his fund of knowledge and his quick flow of ideas mingled with a happy though penetrating wit. One recalls his answer to a foreign visitor's query about the grandstand at Newbury Racecourse; it was, said Peake, a temple of our national religion! He studied man, ancient and modern, with a keen perception of the problems that communities have had to face, and he formed a Citizens' Association at Newbury, and then became honorary curator of Newbury Museum, chairman of the governors of Newbury Grammar School, chairman, and later president, of Newbury General Hospital. At the same time he played his very active part at the Royal Anthropological Institute, of which he became president (1926–28), and at the Society of Antiquaries, serving on its Council during 1928–30. He was a regular attendant at meetings of the British Association for the Advancement of Science and was president of its Anthropological Section in 1922. The Royal Anthropological Institute gave him its Huxley Medal in 1940.

Peake was deeply convinced of the evolutionary interpretation of the story of mankind, and he sought to illuminate many dim corners, particularly the origins of cultivation, of cultivated grain, of ploughing, of metallurgy, of social hierarchies, and of mythologies that succeed one another in the general history of religion. "Ritual continues, its explanations wax and wane." It was a delight to hear his endless suggestions about ancient herdsmen and their seasonal ceremonies for the sorting out of the animals, and their butchering hoists giving the idea of pillars and lintels around a corral and leading on from wood to stone at Stonehenge with a number of new meanings and associations; or, it might be, his view, not always accepted, that prehistoric Beaker pottery was largely a copy of certain kinds of painted pottery by people who were not skilled in painting and who incised the surface for ornament, no doubt recalling at the same time a grass bag technique. His friends celebrated his studies of early wheat (Emmer) by a Christmas card showing Harold chasing 'Wild Emmer' over the hills around the Fertile Crescent.

Peake's Museum at Newbury was unique in its arrangement. The evolution of forms of life was

traced up to man, he being represented by a mirror with *Homo sapiens* written over the top, so that the visitor might realize himself as the product of evolution. Then followed a few carefully selected exhibits of early times beyond accurate dating. The later period, from 3000 B.C. to 2000 A.D., was illustrated by a long wall-space divided equally for the fifty centuries and showing specimens (especially pottery), maps and labels to illustrate the life of the Old World at each stage. A Newbury school-boy, who had used the Museum to some purpose, was being told by an inspector of things that happened "very long ago". The inspector was pleasantly startled to be told, "Oh, but that was in the La Tène period, quite recent in fact".

The "Corridors of Time" (with H. J. Fleure), "The English Village" (1922), "The Bronze Age and the Celtic World" (1922), "The Beginnings of Civilization" (*J. Roy. Anthrop. Inst.*, 1927), "The Introduction of Civilization into Britain" (*ibid.*, 1928), "The Study of Prehistoric Times" (*ibid.*, 1940), and many other contributions to the *Journal of the Royal Anthropological Institute* and to *Man*, as well as to the *Transactions of the Newbury Field Club*, to the "Victoria County History of Berkshire", the books of general exposition "Origins of Agriculture" (1926), "The Flood" (1930) and "Early Steps in Human Progress" (1933) all gave his ever-developing views of the story of humanity.

No account could be satisfactory without mentioning Westbrook House at Boxford, presided over until her death by Mrs. Peake, always brimming with keen intellectual and artistic interests, especially in amateur drama and singing among village folk. For more than forty-five years, Miss Mary Wilson, aided by her colleague Miss Annie Plumb, were the domestic staff and friends of Mr. and Mrs. Peake and of all who gathered around them. Miss Wilson's help in both dramatic efforts and prehistoric studies were gratefully acknowledged. H. J. FLEURE

We regret to announce the following deaths:

Sir Frank Heath, G.B.E., K.C.B., the first secretary to the Department of Scientific and Industrial Research, on October 5, aged eighty-two.

Sir Walter Langdon-Brown, emeritus professor of physic in the University of Cambridge, on October 3, aged seventy-six.

Prof. H. C. Plummer, F.R.S., formerly professor of mathematics at the Military College of Science, Woolwich, on September 30, aged seventy.

NEWS and VIEWS

Committee on Defence Research Policy

A WHITE PAPER has been issued announcing the creation of the office of Minister of Defence, who is to be responsible to Parliament for certain subjects affecting the three Fighting Services and their supply. Mr. A. V. Alexander, formerly First Lord of the Admiralty, has been appointed to the new office. Defence as a whole will be in the hands of a Defence Committee under the chairmanship of the Prime Minister and including as regular members the Defence Minister, the Lord President of the Council, the Foreign Secretary, the Chancellor of the Exchequer, the Service Ministers, the Minister of Labour and the Minister of Supply. Referring to research, the White Paper states that the chief problem is to ensure the continued and complete integration of military and scientific thought at all levels. Full account must be taken of scientific effort in all fields, so that the resources of the country may be used efficiently. To this end a Committee on Defence Research Policy is to be formed, with a permanent chairman who will be a man of science of high standing. This Committee will consist of those responsible, from the operational and scientific points of view, for research and development in the Service Departments and the Ministry of Supply; it will advise the Chiefs of Staff on operational questions, and the Defence Committee itself on wider aspects of the problems involved. Much will, of course, depend on the composition of this Committee on Defence Research Policy; but by this arrangement the machinery is available to ensure that full weight will be given to scientific developments in all matters that are likely to concern the defence of the country.

Consulting Work and Educational Institutions

A STATEMENT issued some time ago by the Joint Council of Professional Scientists dealt with the principles which should govern the acceptance of consulting work by academic men of science (see *Nature*, 157, 86; 1946). A somewhat similar code is incorporated in "A Statement of Research Policy suggested for Inclusion in Research Policies of Educational Institutions", which has been prepared by the Association of Consulting Chemists and Chemical Engineers in the United States and published in *Chemical and Engineering News* of June 10. The statement suggests that it should be the policy of educational institutions to undertake as a rule only such research projects sponsored under contract with industry, government agencies, philanthropic or scientific organisations as seem likely to add to the knowledge of fundamental research, are financed on a basis which contributes to the institution's own research fund, and have as objective the training of research workers. Further, they should extend over a period of a year or more, they should not restrict the institution from undertaking other projects or research, and they should be such as cannot advantageously be undertaken by independent research or development laboratories. Besides this suggested policy, which would seem to be open to evasion or abuse, there are in the statement regulations proposed for private consulting service and for co-operative research, the latter specifying the information to be supplied to the institution before work is begun. As regards commercial testing, it is suggested that no routine commercial testing or analysis of materials, substances or products which might be carried out by an independent industrial or commercial laboratory should be permitted, although tests or analyses intended chiefly to develop new scientific facts should be allowed when they are part of a research programme or necessitate apparatus or equipment not available in private laboratories.

Child Health in Great Britain

A BROADSHEET (No. 248, Child Health and Nutrition) issued by Political and Economic Planning as a study of the services dealing with the nutrition

and health of children, complementary to the study of the maternity services published early in the year, is of renewed interest in view of the food situation and the National Health Service Bill. Pointing out that the primary responsibility for bringing up healthy children must rest on the care and wisdom of their parents, the broadsheet emphasizes that if the retreat from parenthood is to be arrested, the skilled services and economic aid required to restore Britain's greatest and most neglected productive activity—parenthood—must be provided readily and without stint. Present divisions of the welfare and school medical services militate against continuity of medical care for the individual child, and its critical analysis of the present and future services leads P.E.P. to stress that in the nutritional field the greatest need is to implement fully the powers and duties that already exist, while the first need for the child health services is for co-ordination. Co-operation between health visitor and general practitioner, medical officer and children's physician is made difficult by the present administrative arrangements. Secondly, a medical service for children should be fundamentally a health service rather than a sickness service. The health services should study normal growth and development, about which too little is known, and the broadsheet strongly emphasizes the importance of research. Without a high standard of medical teaching and much extended research on such problems as breast-feeding, nutrition, physical education, the influence of social factors on child health, and on all the aspects of normal growth, the best organised medical service can do little. With the proposed organisation of the hospital services in university regions, the future institutes of child health should be able to extend their influence beyond the immediate confines of the teaching centre and raise the standard of all child health services in the region.

The National Grid of the Ordnance Survey

THE Departmental Committee appointed in 1935 by the Minister of Agriculture and Fisheries to consider Ordnance Survey plans and maps recommended that the large-scale plans of Great Britain should be re-cast on national sheet lines and that a national grid, with the metre as unit, should be superimposed on all large-scale plans and most of the small-scale maps. The recommendation compels the use of a projection that will not introduce unacceptable distortions, on any of the scales, when it is extended over an area the size of Great Britain. Accordingly an orthomorphic projection, known as the Transverse Mercator, with its origin at lat. 49° N., long. 2° W., has now been adopted as the national projection for general use over Great Britain. When rectangular co-ordinates are referred to this origin, the easting co-ordinates of points to the west of the central meridian are negative, and the northing co-ordinates, though all positive, become inconveniently large for points in northern Scotland. To avoid these difficulties, 400 km. have been added to all easting co-ordinates and 100 km. subtracted from all northing co-ordinates. This places the working position of the origin a little to the south-west of Lands End and ensures that the co-ordinates of all points on the mainland of Great Britain are positive and less than 1,000 km.

The Ordnance Survey has now issued a pamphlet (Booklet No. 1/45, "A Brief Description of the National Grid and Reference System", H.M. Stationery Office, 1946. 4*d*. net) which briefly describes the geodetic and mapping situation in Great Britain at the time the Committee was appointed, and the steps taken to implement its recommendations. It then details a method of giving the grid reference of any point on maps and plans of all scales. This pamphlet will be of the greatest value to all map users, and to students of geography in particular, for whom the national grid will provide a most convenient aid for the recording of positions and statistical information.

Work of Cultural Missions

WHETHER as regards its origin, its immediate significance, or its promise for the future, Bulletin 1945, No. 11, of the Federal Security Agency (U.S. Office of Education) entitled "Report on the Cultural Missions of Mexico" is a noteworthy report. Its subject is the mission work done by a band of enthusiastic and patient Mexicans among the Indians in their remote villages. A preface written by Mr. J. W. Studebaker, U.S. Commissioner of Education, reveals that in September 1943 he had the opportunity of meeting the writer of the report and of visiting with him a group of Indian villages in which one of the missions was functioning. The report was thereupon written by the chief of the missions department, and here is the English translation. The work being done, says Mr. Studebaker, was an inspiration to him as an educator and as a citizen of a neighbouring country. The broad educational objectives, he proceeds, and the methods employed in this project for teaching Indian people a better way of life give confidence and inspire one with the belief that an isolated and somewhat estranged people of a great land will, through these means, be prepared for modern life and brought into the fold of genuine citizenship. Mr. Studebaker's closing words strike one as most remarkable. It is hoped, he says, that this report will contribute to a greater understanding of the important educational accomplishments "of our nearest southern neighbour, and that it will constitute an inspiration and a challenge to the educators of the United States". Following the report itself, a number of interesting and informative photographs, supplied by the author of the report, are added. Further, in order that the reader may secure more information concerning cultural missions in Mexico, either from English or from Spanish sources, a list of related readings, prepared in the Division of International Educational Relations, is included.

Fuel Economy in the United States since 1939

THE United States National Committee of the World Power Conference (Central Office, 36 Kingsway, London, W.C.2) has issued a report on that country's reactions to war conditions. Economy of fuel was necessary, but in ways which differ from those experienced in Britain. Since hostilities ceased, except for temporary effects, such as labour troubles, difficulties have disappeared and efforts to save fuel are based on economics rather than availability of supplies. During the War, production suffered from labour troubles and especially transportation problems. This led to an increase in the use of hydro-generated electricity from 44 to 80 billion kWh. Attempts were made to increase production—by technical devices in the case of liquid and gaseous fuels. In coal production, major developments were "salvaging coal formerly rejected", which recalls British use of 'outcrop coal' and 'washery slurries'.

Alternative fuels such as 'coal oil' mixtures were tried but not used extensively. Contrary to present British practice, the principal change was from oil-firing to coal-fired equipment, and in household use from oil to gas. There were control organisations—a petroleum administrator and a 'solid fuel administrator', and as civilian fuel became short, rationing was developed. Judged by British standards, the measures adopted do not sound onerous. For example, the general consumer would experience a restriction of solid fuels to seven-eighths of normal use. Various steps to conserve fuel were enforced, such as the adoption of 'brownout' and 'dimout' rules, reduction of space heating and organisation of a fuel economy campaign.

Post-war conditions are expected to bring more efficient equipment in domestic practice. Where hydro-electric power is available, and off-peak current can be used to store heat, there will be more space-heating by electricity. No great reduction of fuel consumption is anticipated, however, in view of the increased demand for improved amenities. No radical improvements in conventional equipment are expected. New designs include the gas turbine, hot-air turbine and the heat pump for cooling and heating. The War has compelled increased interest in fuel education—enforced by the "advent of shortages and increases in the relative costs of fuel". In this respect conditions resemble those in Britain.

Abnormal Solar Radiation on 75 Megacycles

Messrs. S. E. Williams and P. Hands, of the Department of Physics, University of Western Australia, have sent a long communication referring to observations made there of solar radio-frequency radiation on a wave-length of 4 metres, using a Yagi aerial of moderate directivity, mounted on a polar axis. Measurements of the ratio of currents due to solar-plus-receiver noise and receiver noise only, recorded with the dipole short-circuited, were made with a milliammeter in the anode circuit of the (linear) second detector. Later an oscillograph was used to secure a continuous record. Continuous observations were maintained for from three to five hours each day, during the passage of the large sunspot group having mean meridian passage on July 26·7 (G.M.T.) and the two following groups with mean meridian passage on August 2·4. On the basis of these observations they divide solar radio-frequency noise roughly into two components, one 'steady' or relatively slowly variable (Component I), the other abruptly variable (Component II). A striking example of the variation of the so-called Component II was observed on August 2, when it was estimated that this 'storm' involved changes in noise emission by 50–100 *times* in a few seconds.

These short-period variations during 03h. 14m. 10s.–03h. 29m. 10s. (approx. G.M.T.) corresponded with visual changes on the sun's disk as recorded on spectrohelioscope observations made by Watheroo Magnetic Observatory. A similar but less intense disturbance, during which the milliammeter showed increases in solar/receiver noise from 10 per cent to more than 150 per cent, was recorded on the same day between 04h. 51m. and 04h. 57m. 30s. (G.M.T.), when ionospheric equipment at Watheroo recorded a fade-out of intensity 4 (scale 1–9) during 04h. 45m.–05h. 00m., followed by a spectrohelioscope report of a faint prominence at 05h., indicating a flare at about 04h. 50m.

Messrs. Williams and Hands point out that since 75 mc./s. radiation cannot penetrate regions where the electron density is greater than 10^8/c.c., which would be exceeded in the lower chromosphere, the correlation of solar noise generation with prominence activity seems probable. Further, as disturbances involving the emission of Component II are not necessarily accompanied by fade-outs, whereas chromospheric flares occurring within an hour or so of local apparent noon almost always produce fade-out effects, they suggest that correlation of Component II with flares would not be generally observed, but that coincidences between these phenomena would depend on the level at which increased excitation of the $H\alpha$ line occurs. This note of work at the University of Western Australia should be read in conjunction with the communication by Dr. A. C. B. Lovell and C. J. Banwell on p. 517 of this issue of *Nature*.

Survey of British Somaliland

Suggestions for a general survey of British Somaliland were made before the War in connexion with water supplies, soil erosion and other problems affecting the general development of the country, but were not put into execution at the time. The Military Government of the Protectorate has now issued a report outlining surveys made and data collected from 1942 onwards, and recording the work of a special department under Major J. A. Hunt from its inception in August 1943 until December 1944 (Report on General Survey of British Somaliland, 1944. Pp. 12 + 17 charts. (Burao: Gov. Press, 1946.) 3*s*. 6*d*.). The programme of work of the department conforms roughly to that advocated by Dr. E. B. Worthington in "Science in Africa", and starts with the accurate collection of meteorological and geological data, followed by a soil survey, plant and then animal ecology. The preliminary results are illustrated in a series of maps and diagrams published with the report, covering rainfall, plant ecology and tribal migrations and potential developments in minerals, water, agriculture and roads. The General Survey has now been recognized in principle by the Colonial Office, and funds have been provided under the Colonial Development and Welfare Act to finance an "economic survey and reconnaissance" with a programme extending until 1950. The water and mineral surveys will be made by two specialist geologists on arrival and may take up to two years. Altitude, rainfall and plant ecology are closely interrelated, and rain crop cultivation can only be considered and tested in a limited area above 4,000 ft. Sites are recommended for irrigation gardens and date plantations, and a new road from Berbera to El Afwein and Hudun is recommended as being situated on the most direct route to the eastern part of the Protectorate with no difficult escarpments to surmount. The Military Governor points out in his introduction to the report that the political and economic life of the Protectorate and neighbouring countries is threatened by increasing migrations of Somali tribes, who will be unable to find subsistence in their own country if conditions continue to deteriorate. The report strongly recommends publication of reports and specialist papers to stimulate interest in research, and also that when the two years survey of water and minerals has been carried out, the Survey should organise a technical library and laboratory in Burao, which is the natural centre for any scientific work in the Protectorate.

International Students' Federation

THE account given in the first issue of the *British Medical Students' Journal* of events which led to the formation of the new International Students' Federation and of the rebirth of the Czech universities is grim but inspiring reading. On November 17, 1939, the Germans closed the Charles University at Prague, shot nine heads of the student organisations and sent many male students either to concentration camps or to enforced labour in Germany. In memory of these and other early sacrifices, this day was celebrated in Britain and elsewhere as International Students' Day, and by the end of the War it was being celebrated all over the world as a day of remembrance and renewed resolve. The Czech students in exile in Britain wished that the first peace-time celebration of this day should be held in Prague, and, in November 1945, they invited students from fifty-one countries to be their guests. Some four hundred students accepted this invitation, and the article pays a tribute to the Czech students—and, indeed, to the whole population—for their reception of so many visitors only six months after the liberation of the country. Working in co-operation with the National Union of Students, a preparatory committee had already drafted the constitution of the new International Students' Federation. Co-operation with the World Federation of Democratic Youth and with the World Youth Conference held in London in November 1945 ensured further progress. The Prague Congress in 1945, an account of which is given, expressed the hope that the new International Students' Federation would be finally constituted during the summer of this year.

Working in Wood

UNDER the auspices of the Department of Scientific and Industrial Research the Forest Products Research Laboratory has issued a "Handbook of Woodcutting" (H.M. Stationery Office, 1946. Pp. 44. 9*d*. net) by P. Harris. Owing to the numerous requests received at the Laboratory for help in sawmilling and woodworking problems, it became obvious that a handbook on correct technique was required. The present publication is designed as a handy reference book, with a scientific background, from which the mathematical aspects of the subject have been omitted, with the exception of certain simple formulæ. The handbook contains detailed information and recommendations relating to the various forms of sawing and to planing, moulding, tenoning, mortizing, boring and turning operations. Diagrams and tables are added where necessary. Now that the area of forests is growing so convincingly in Great Britain, it is to be hoped that the time-honoured forms of handling wood by hand turnery, bending, shaving, toy carving and so forth, for all of which certain types of tools are required and must be kept in perfect condition, will be kept alive or brought back—especially hand carving by the new forest populations, as so commonly to be found in parts of Europe.

The European Chafer in America

THE Cornell University Agricultural Experiment Station has issued Memoir 266 on the "External Morphology of *Amphimallon Majalis*, the European Cockchafer", by F. H. Butt (University Ithaca, New York, December 1944). The European chafer, it is of considerable interest to hear, is a very modern introduced species, first reported in Wayne County, New York, in 1942, as being very destructive to lawns and to pasture lands in this region, the greatest destruction being done during its larval stages. The insect was closely studied in its three larval stages, and a life-history was published in 1943. The paper describes the external morphology of these various stages of the insect, with thirteen excellent plates. The generic name *Amphimallon* is attributed to Latreille. Most entomologists and foresters of the older generations will be better acquainted with the insect under its old-time name of *Melolontha vulgaris*, a well-known pest in European continental hardwood forests, especially oak, as is the case in Great Britain.

X-Ray Analysis in the Steel Industry

THE X-ray Analysis Group of the Institute of Physics has arranged a meeting to take place in the conference hall of the Royal Victoria Hotel, Sheffield, on November 8 and 9. On November 8, Dr. A. J. Bradley will speak on "The Intensity Relations of Debye–Scherrer Powder Diffraction Lines", and Dr. W. A. Wood on "The Application of X-rays to the Study of Stresses in Metals". The morning session on November 9 will include three papers, one by Prof. G. I. Finch on "The Surface Structure of Metals", one by Mr. H. J. Goldschmidt on "An X-ray Investigation of Electro-Deposited Chromium", and one by Dr. A. H. Jay on "Some Successes and Failures in the Application of X-rays to Industrial Problems". The meeting is open to all without charge ; those who wish to take part in the discussions following these papers should notify Mr. F. A. Bannister (Hon. Sec.), Department of Mineralogy, British Museum (Natural History), London, S.W.7.

Racemic Acid

IN an interesting paper recently available in Britain, Prof. Delépine (*Bull. Soc. Chim.*, 8, 463 ; 1941) gives some historical facts relating to the discovery of racemic acid, which supplement the note by Prof. A. Findlay (*Nature*, 140, 22 ; 1937). The acid was obtained accidentally in the crystallization of tartaric acid in a factory in Thann, Alsace, belonging to Kestner, which seems to have ceased operations about 1822, and is first mentioned by John in his "Handwörterbuch der allgemeinen Chemie" in 1819. The name 'racemic acid' was first used by Gay-Lussac in his lectures, notes of which were published in 1828, and he showed that it had the same composition as tartaric acid. Berzelius, in 1830, in discussing this fact, first used the word 'isomer'. The further history of the acid, in particular in the work of Pasteur (who was the first to use the name 'racemic' in general), is given in the article.

Journal of the British Grassland Society

THE first number of the *Journal of the British Grassland Society* has now been issued. The price of Volume 1 (Nos. 1 and 2), 1946, is 10*s*., and application for purchase should be made to the Secretary, British Grassland Society, Agricultural Research Building, Penglais, Aberystwyth. The volume opens with a foreword by Sir George Stapledon and also includes his presidential address, with ley farming as its principal theme, given at the inaugural meeting on June 20, 1945. Other contributors deal with various questions of interest in grassland management. In tests to compare different techniques for measuring grass production, a close correlation is shown between output in terms of grass clippings by the movable cage method with that from live weight increase in grazing cattle. Other grazing experiments

THE RUBBER RESEARCH INSTITUTE OF MALAYA

KUALA LUMPUR

Applications are invited for the post of Director of the Rubber Research Institute of Malaya. This Institute, situated at Kuala Lumpur, was established in 1925, and is constituted under Enactment of the Federated Malay States, for the purpose of research into and investigation of all problems and matters relating to rubber and the provision of information relating to the same.

Candidates should possess high scientific attainments and wide administrative experience. Salary $1,500/- to $1,800/- per mensem (Straits currency), according to qualifications, with the possibility of a higher figure for a man with exceptional qualifications; together with an allowance for motor-car maintenance. The question of paying a cost-of-living allowance during the prevalence of abnormally high prices is under consideration. Long leave on full salary at the rate of eight months leave for every 2½ years service. Rent-free quarters with heavy furniture are provided. First class passages, and medical attention, are provided, also for wife and two children under ten years. The Director must become a member of the Institute's Provident Fund, contributing 10 per cent of his salary, a like contribution being made by the Board.

Applications, stating age, present occupation, previous experience and date when available for duty, together with the names of three referees, should be received (in duplicate) by the Acting Secretary, London Advisory Committee for Rubber Research (Ceylon and Malaya), Imperial Institute, London, S.W.7, within 60 days of the date of publication of this advertisement. A copy of the application should be sent to the Secretary, Rubber Research Institute of Malaya, P.O. Box 150, Kuala Lumpur, Malaya. ($ = 2s. 4d. $100 per mensem = £140 per annum.)

CIVIL SERVICE COMMISSION, DUBLIN

POSITIONS VACANT

METEOROLOGICAL OFFICER CADETS (20) IN THE DEPARTMENT OF INDUSTRY AND COMMERCE, DUBLIN

Applications for appointment to the above-named situations are invited from Irish Nationals possessing the requisite qualifications.

Application forms for and particulars of the posts may be obtained from the Secretary, Civil Service Commission, 45 Upper O'Connell Street, Dublin. Salary: £180 a year plus a bonus of £179 7s. On satisfactorily completing a prescribed course of training extending over not less than two years, Cadets will, on fulfilment of certain conditions, be appointed Meteorological Officers on a salary scale of £200–£20–£500 a year plus bonus. Maximum Age Limit: 32 years on November 1, 1946, except in the case of persons at present serving in an established capacity (civil) in a Department of State or in the case of persons with certain specified service in the Defence Forces or such Auxiliary Defence Services as may be determined. Essential qualifications: (a) 1st or 2nd class honours University degree with Physics or Mathematical Physics or Mathematics as a major subject and 1st or 2nd class honours in that subject or (b) 1st or 2nd class honours University degree in Mechanical and/or Electrical Engineering or in Civil Engineering or (c) University degree in Meteorology or (d) a qualification equivalent to any one of the foregoing.

Latest time for accepting completed application forms: 5 p.m. on November 15, 1946. Note—Open competitions for posts as Meteorological Officer Cadets will also be held in each of the years 1947–1949.

LONDON PASSENGER TRANSPORT BOARD

Applications are invited from persons whose age does not exceed 45 years for the post of Progress and Materials Superintendent at the Board's Chiswick Works. The duties of the post involve responsibility for the administration of the Progress and Material Control Section and require a knowledge of modern factory control methods, including Progress Systems and Factory Control stores. A sound knowledge of office systems and ability to control both wages and administrative staff is essential. The commencing salary will be £1,000 p.a. plus war wage (at present £72 10s. p.a.). The successful candidate will be required to pass a medical examination and to serve satisfactorily a probationary period. Membership of the Board's superannuation fund is compulsory. Canvassing either directly or indirectly will disqualify. Applications giving full particulars of education, business and other experience, professional or other qualifications, and present remuneration and age, should be sent not later than October 26, 1946, to the Chief Staff and Welfare Officer (reference E.R./E.260), London Passenger Transport Board, 55 Broadway, S.W.1.

MANCHESTER MUNICIPAL COLLEGE OF TECHNOLOGY

(Faculty of Technology in the University of Manchester)

Appointment of

ASSISTANT LECTURER IN TEXTILE CHEMISTRY

The Governing Body invites applications for an Assistant Lectureship in Textile Chemistry in the College of Technology, with the title and status of Assistant Lecturer in the University of Manchester. Salary scale: £420 per annum, rising by annual increments of £20 to £500, with commencing salary according to qualifications. Candidates should possess a degree in Technology or Science, or a qualification of the Royal Institute of Chemistry, and should have had experience in industry. Knowledge of Textile Printing would be a recommendation.

Conditions of appointment and form of application may be obtained from The Registrar, College of Technology, Manchester, 1. The last day for the receipt of applications is Monday, October 28, 1946.

Canvassing, either directly or indirectly, will disqualify a candidate for appointment.

J. E. MYERS,
Principal of the College.

MANCHESTER MUNICIPAL COLLEGE OF TECHNOLOGY

(Faculty of Technology in the University of Manchester)

Appointment of

ASSISTANT LECTURER IN MATHEMATICS

The Governing Body invites applications for an Assistant Lectureship in Mathematics, with the title and status of Assistant Lecturer in the University of Manchester. Salary scale: £420 per annum, rising by annual increments of £20 to £500 per annum. Commencing salary according to qualifications.

Conditions of appointment and form of application may be obtained from The Registrar, College of Technology, Manchester, 1. The last date for the receipt of applications is Monday, October 28, 1946.

Canvassing, either directly or indirectly, will disqualify a candidate for appointment.

J. E. MYERS,
Principal of the College.

BIRMINGHAM UNITED HOSPITAL

The General Hospital.
The Queen Elizabeth Hospital.

(Also incorporating the Queen's Hospital 1840–1941).

THE QUEEN ELIZABETH HOSPITAL

Applications are invited for the post of Assistant in the Clinical Laboratory at the Queen Elizabeth Hospital. Candidates (female) should possess a B.Sc., or have had other scientific training. Salary £250 per annum, rising to £300, by annual increments of £25. Duties consist of routine blood examinations, previous experience not essential. Applications, together with three recent testimonials, should be made at once to the undersigned, from whom further particulars may be obtained.

G. HURFORD,
The Queen Elizabeth Hospital, House Governor.
Birmingham, 15.

DALHOUSIE UNIVERSITY

HALIFAX, CANADA

DEPARTMENT OF PHYSICS

Applications are invited for an Assistant Professorship at an initial salary of $3,200 per annum with yearly increases, to begin September 1, 1947. Duties will include a moderate amount of teaching, and the appointee will be expected to engage in research for which he will be given opportunity. If the applicant has had considerable research experience, the appointment may be raised to that of Associate Professor at a higher salary.

Applications, giving full particulars, including qualifications, experience and the names of two referees, should be forwarded, preferably by Air Mail, to the President of the University, to arrive not later than November 1, 1946.

CITY OF LEICESTER EDUCATION COMMITTEE

COLLEGIATE SCHOOL FOR GIRLS

(Headmistress: MISS D. R. SMITH, M.A., J.P.)

Required in January a well-qualified Science Mistress to take Physics and Chemistry in the General Science Course up to School Certificate and Chemistry in the Sixth Form up to University Scholarship standard. Salary according to Burnham Scale.

Apply immediately by letter with copies of testimonials to the Headmistress at the School.

ELFED THOMAS,
Director of Education.

Education Department,
Newarke Street,
Leicester.

THE ROYAL SOCIETY SCIENTIFIC PUBLICATIONS GRANT

The Council of the Royal Society invites applications for grants from the Parliamentary Grant-in-aid of Scientific Publications. This grant-in-aid is provided for the assistance of scientific publications in the United Kingdom, particularly but not exclusively those of scientific societies and institutions. Applications should be typewritten and the amount applied for should be clearly stated. In the case of societies or institutions, a statement of their financial position should be submitted. Applications should reach the Assistant Secretary, The Royal Society, Burlington House, London, W.1, not later than November 15, 1946.

LONDON COUNTY COUNCIL

Applications are invited for appointment to the position of full time Junior Assistant Physicist in the Council's hospitals service. The duties will be mainly in connection with X-ray and radium work at Hammersmith Hospital, Ducane Road, W.12, but the person appointed will be required to undertake any other duties which may be allotted to him or her from time to time. Salary £350 a year—£26—£400 a year with, at present, cost of living addition of £78 a year (men) or £72 (women). There are no emoluments.

Application forms giving full particulars obtainable (stamped addressed foolscap envelope necessary) from Medical Officer of Health (S.D.6), London County Council, County Hall, S.E.1, are returnable by October 26. Canvassing disqualifies.

UNIVERSITY OF CAPE TOWN

SENIOR LECTURER IN ZOOLOGY

Applications are invited for a Senior Lectureship in the Department of Zoology. The post is vacant from 1947, salary scale £675 plus £25—£775 per annum, plus a temporary cost of living allowance. Qualifications in comparative physiology and experimental methods are desirable. Applications from candidates who have been on military or other national service will be given special consideration; applicants are advised to give particulars of such service. Write quoting G.412, to Ministry of Labour and National Service, Appointments Department, Technical and Scientific Register, Room 572, York House, Kingsway, London, W.C.2, for application forms which must be returned, in duplicate, together with copies of testimonials, and the names of three referees, by November 12, 1946.

UNIVERSITY OF CAPE TOWN

SENIOR LECTURER IN PHYSICS

Applications are invited for a Senior Lectureship in Physics. The post is vacant from 1947. Salary scale £675 by 25–£775 per annum plus a temporary cost of living allowance. Applications from candidates who have been on military or other national service will be given special consideration; applicants are advised to give particulars of such service.

Write quoting A.328 to Ministry of Labour and National Service, Technical and Scientific Register, Room 572, York House, Kingsway, London, W.C.2, for application forms which must be returned, in duplicate, together with copies of testimonials, and the names of three referees, by November 12, 1946.

NOTTS EDUCATION COMMITTEE

COUNTY TECHNICAL COLLEGE, WORKSOP

Required as soon as possible, preferably before January 1, 1947: Head of Engineering and Science Department. Person appointed should preferably have Science qualifications with some knowledge of Engineering. Engineers applying for the post should preferably be able to offer Electrical Engineering to Higher National Certificate standard and have some general knowledge of Science. The person appointed will also act as Deputy Principal. Salary according to Burnham Scale, Grade I Head of Department: £600 by 25–£750.

Graduate Assistant in Electrical Engineering or Science. Complementary to the above, to teach to National Certificate and Intermediate Degree standard in the College and in the Secondary Technical School. Salary according to Burnham scale.

Applicants should apply in writing at once, giving full particulars of their qualifications, experience, present post, and supported by testimonials.

UNIVERSITY COLLEGE LEICESTER

The Council recently invited applications for Professorships in English, History, Mathematics and Physics at a minimum commencing salary of £1,000 p.a. The Council, however, is now in a position to offer a higher commencing salary and has decided to re-advertise the four Chairs at a commencing salary of £1,200 p.a. with participation in the Federated Superannuation System for Universities. Further particulars may be obtained from the Registrar to whom applications should be submitted not later than November 16.

NATIONAL MILK TESTING AND ADVISORY SCHEME

Applications are invited for the post of Area Supervisor to supervise the work of the above scheme in North Staffordshire, and to take charge of the Newcastle Area Laboratory.

Applicants should possess a degree in science or the N.D.D. and should have experience in dairy bacteriology, and it is desirable that they should be able to drive a car. Salary scales are as follows: Men, £200–£300 p.a. lower range, £300–£400 p.a higher range. Women, £200–£275 p.a. lower range, £275–£320 p.a. higher range. War bonus payable in addition throughout. Further particulars can be obtained from the Advisory Bacteriologist, Provincial Laboratory, Bank House, Newport, Shropshire.

AUCKLAND UNIVERSITY COLLEGE

AUCKLAND, NEW ZEALAND

Applications are invited for a Senior Lectureship in Physics. Salary £750 per annum (New Zealand currency) rising to £825 per annum. Allowance for travelling expenses. Further information may be obtained from The Secretary, Universities Bureau of the British Empire, 24 Gordon Square, London, W.C.1. Closing date for the receipt of applications is November 15, 1946.

AUCKLAND UNIVERSITY COLLEGE

AUCKLAND, NEW ZEALAND

Applications are invited for a Lecturer in Geography. Salary £600 per annum (New Zealand currency) rising to £700 per annum. Allowance for travelling expenses. Further information may be obtained from The Secretary, Universities Bureau of the British Empire, 24 Gordon Square, London, W.C.1. Closing date for the receipt of applications is November 15, 1946.

AUCKLAND UNIVERSITY COLLEGE

AUCKLAND, NEW ZEALAND

Applications are invited for a Lecturer in Philosophy. Salary £600 per annum (New Zealand currency) rising to £700 per annum. Allowance for travelling expenses. Further information may be obtained from The Secretary, Universities Bureau of the British Empire, 24 Gordon Square, London, W.C.1. Closing date for the receipt of applications is November 15, 1946.

UNIVERSITY OF BIRMINGHAM

FACULTY OF SCIENCE

DEPARTMENT OF CHEMICAL ENGINEERING

Applications are invited from graduates in Chemistry for a Research Scholarship in organic chemistry with particular reference to the chemistry of hydrocarbons. The Scholarship is tenable in the Department of Chemical Engineering, and the amount is £220 in the first year, £240 in the second year, and £260 in the third year, with remission of fees. The holder of the Scholarship is eligible to study for a Ph.D. degree.

Applications, with the names of three referees, should be sent to the Director of the Department of Chemical Engineering, The University, Edgbaston, Birmingham, 15, before November 1, 1946.

CANTERBURY EDUCATION COMMITTEE

CANTERBURY TECHNICAL INSTITUTE

Applications are invited for the post of full-time teacher in Commerce in the County Technical Secondary School for Boys. The qualifications for the post are a Degree in Economics or Commerce. Industrial experience would be an additional qualification. Salary in accordance with Burnham Scale. Further details and application forms may be obtained from the Principal, Canterbury Technical Institute, Longport Street, Canterbury, and should be returned not later than Saturday, November 16.

JAMES GREEN,
Chief Education Officer.

78 London Road, Canterbury.

UNIVERSITY OF BRISTOL

Applications are invited for the post of Lecturer in Pharmacology. The selected applicant will be expected to assist in the teaching work of the department but will have ample time for research. Preference will be given to candidates who have experience in Biochemistry and/or Experimental Physiology. The salary for a candidate holding a medical qualification will range from £400 to £800 per annum, according to experience. The successful candidate will be expected to take up his duties as soon as possible. Practitioners serving in H.M. Forces are invited to apply. Applications should reach the undersigned, from whom further particulars may be obtained, not later than October 26, 1946

WINIFRED SHAPLAND,
Secretary and Registrar.

UNIVERSITY OF LONDON

A course of two lectures entitled "Review of the Dietetic Factors in Liver Disease" will be given by Prof. L. J. Witts, M.D., F.R.C.P. (Nuffield Professor of Clinical Medicine, University of Oxford) in the Meyerstein Lecture Theatre of Westminster Hospital Medical School (Horseferry Road, London, S.W.1), at 5 p.m. on Friday, October 18 and Tuesday, October 29, 1946. Admission Free, without ticket.

JAMES HENDERSON,
Academic Registrar.

UNIVERSITY OF OXFORD

DEPARTMENT OF ZOOLOGY

Senior Museum Assistant required. Skill and experience in museum methods and technique essential. Initial salary from £5 4s. per week according to qualifications.

Apply, stating qualifications and experience, and giving references, to the Secretary, Department of Zoology, University Museum, Oxford.

UNIVERSITY COLLEGE OF SWANSEA

The Council of the College invites applications for the post of Professor of Geology and Head of the Department of Geology and Geography. Salary £1,250 per annum. Further particulars may be obtained from the Registrar, University College, Singleton Park, Swansea, by whom applications must be received on or before November 9, 1946.

THE UNIVERSITY OF SHEFFIELD

Applications are invited for a post of Senior Lecturer in Organic Chemistry. Further particulars can be obtained from the undersigned to whom applications (four copies) including the names and addresses of referees, and, if desired, copies of testimonials, should be sent by November 16, 1946.

A. W. CHAPMAN,
Registrar.

THE UNIVERSITY OF SHEFFIELD

DEPARTMENT OF BIOCHEMISTRY

Professor: H. A. KREBS, M.A., M.D.

There are salaried vacancies for graduates who wish to train in biochemical research under the Head of the Department. The salary will depend on qualifications and experience. Persons interested in these vacancies should communicate, in the first place, with the undersigned, giving particulars of their careers.

A. W. CHAPMAN,
Registrar.

UNIVERSITY OF LEEDS

DEPARTMENT OF PHYSICS

Applications are invited for the post of Assistant Lecturer in Physics, at a commencing salary of £400–£450 according to qualifications and experience. Further particulars may be obtained on request. Applications should reach the Registrar, the University, Leeds, 2, not later than November 9.

UNIVERSITY COLLEGE OF NORTH WALES, BANGOR

A Probationary Assistant Lecturer in Physics is required as soon as possible, and in any case not later than January 1, 1947. Initial salary £400 p.a. plus superannuation. Applications should be lodged with the undersigned not later than November 9, 1946.

UNIVERSITY COLLEGE OF HULL

Laboratory Steward and Lecture Assistant required for the Department of Chemistry. Wage from £5 to £6 a week according to qualifications and experience. Application to the Registrar as soon as possible.

Textile Machinery Makers, Ltd., will shortly consider the appointment of a new Director of Research to take charge of a new Research Department. The aim of this Department will be to evolve along scientific lines improved designs for existing machines and designs for machines based on new principles. The Director will be expected to approach his problems in a broad and fundamental way from the point of view of textile technology as well as engineering. Essential qualifications for the post are high scientific attainments with an honours degree preferably in physics (or in engineering with a sound knowledge of physics), ability to inspire a scientific staff and to co-operate closely with industrialists. Previous knowledge of the textile industry is not essential. The commencing salary will be in the range of £1,500 to £2,500. Applications should in the first instance be made in confidence to: The Managing Director, Textile Machinery Makers, Ltd., 60, Huddersfield Road, Oldham, Lancs.

A Junior Assistant Chemist required for Analytical Laboratory (Food and Pharmaceutical Preparations). Education to Intermediate Standard desired but not essential. Some practical experience an advantage. Write Box No 871, Spottiswoodes, Regent Street, Kingsway, W.C.2.

Director of Research required immediately for recently-established Research Laboratory in London attached to well-known company manufacturing antiseptics, etc. Primary qualification a wide experience in Bacteriology. Applicant should also have interest in, and some knowledge of, cognate subjects, especially Chemistry. Adequate equipment and assistance are provided, and duties will involve short and long-term investigation in Bacteriological Department, and the planning and direction of Bio-Chemistry and Chemistry Sections of the Laboratory. The salary offered will be commensurate with qualifications and experience. Pension Scheme is in operation. Applications, with full details of qualifications, experience, age, and the names of three referees to whom confidential enquiries can be addressed, should be sent to Box 723, T. G. Scott & Son, Ltd., 9 Arundel Street, London, W.C.2.

Vacancies exist in the Research Laboratories, situated 25 miles from London, of a large group of Engineering and Scientific Companies, for Senior Engineers to take charge of:—

1. Laboratory engaged on the design and development of industrial control equipment.
2. Laboratory engaged on the design and development of communication type radio receivers and transmitters.
3. Laboratory concerned with the theoretical design of electrical circuits embodying electronic devices.

Applicants should hold 1st class honours degrees in Engineering or Science and have had at least 6 years experience in a laboratory. Age not less than 30 years. Initial salary £600–£800 per annum. Applicants for vacancy 3 should have a good knowledge of advanced mathematics. Apply Box 716, T. G. Scott & Son, Ltd., 9 Arundel Street, London, W.C.2.

Senior Physicist required to take charge of Physics Section, Research Laboratory, Birmingham. Honours Degree, Physics, with at least five years research experience in physical metallurgy. Must have knowledge of modern theory of solids, X-ray crystal analysis, methods of determination of thermal, magnetic and electrical properties of materials and experience in the application of this knowledge to the study of metals and alloys. Evidence of administrative and organising ability advantageous. Apply to Manager, Development and Research Department, The Mond Nickel Co., Ltd., Grosvenor House, Park Lane, London, W.1, stating age, experience, qualifications, salary required, etc. Mark envelope "Confidential S.P."

Aluminium Laboratories, Limited, Banbury, Oxon, invite applications for the position of Chief Librarian and Information Officer, to be responsible for organising and enlarging library covering metallurgy, physics, chemistry, engineering, geology and patents. His work would include supervision of central technical files, abstraction, co-ordination and translation of literature, particularly on the research and development of aluminium and its alloys and their application to industry, also the maintaining of contacts with sources of information in associated companies in other countries. Good language and scientific qualifications are required and will command an appropriate salary.

Laboratory Technician with training in pathological and bacteriological technique required for the City Hospital Laboratory, Aberdeen. The basic salary is £215 per annum, rising by annual increments of £10 to £235, with, in addition, a cost of living bonus of £78 per annum for males, and £63 per annum for females. The post is superannuable.

Applications, giving full particulars, with copies of recent testimonials should be sent to Dr. J. Smith, Public Health Laboratories, City Hospital, Aberdeen.

D. B. GUNN,
Town Clerk.

Librarian to take charge of the Reference and Lending Libraries of The Institution of Electrical Engineers. Candidates must have had an electrical engineering education and training and a practical knowledge of the conduct of a large collection of scientific books. Languages and knowledge of decimal classifications also desirable. Apply by letter only, stating salary required to The Secretary of The Institution of Electrical Engineers, Savoy Place, London, W.C.2.

Electrical Engineer or Electronic Physicist required, capable of original calculations and design work on electronic equipment, wave propagation problems and similar work. Degree or equivalent and some research or design experience essential. Approximate age 25–30. Salary £400 approx. Apply Staff Officer, British Insulated Callender's Cables, Ltd., Erith Works, Belvedere, Kent. Ref. SR.8.

(*Continued on page* iv *of Supplement.*)

(*Continued from page* iii *of Supplement.*)

Assistant Biochemist—Queen Elizabeth Hospital, Birmingham. Applications, addressed to the undersigned, are invited. Candidates must have had post-graduate training in research; experience in clinical biochemistry is desirable. Commencing salary—£600 per annum.

G. HURFORD,
House Governor.

A technical assistant is required in the Information Department of the British Scientific Instrument Research Association, 26 Russell Square, London, W.C.1, to help with abstracting, answering technical inquiries, classifying technical literature. Salary £300–£450 according to qualifications. Applicants, who should be graduates (pref. phys. or el. eng.) should apply in writing.

Metallurgist required for large oil refinery in the North-West. Candidates must have First or Second Class Honours Degree (or equivalent) and age not over 30. Sound knowledge of corrosion and alloy metals essential. Some previous industrial experience desirable but not essential. Salary according to age, qualifications and experience. Reply to Box 718, T. G. Scott & Son, Ltd., 9 Arundel Street, London, W.C.2.

Laboratory Steward (Grade B) required in the Department of Chemistry, Middlesex Hospital Medical School, London, W.1. Salary according to age and experience. Application should be made in writing and sent to the Medical School Secretary not later than October 31.

Applications are invited from Metallurgists or Chemists with some knowledge of Metallurgy, for the post of information officer in a research laboratory in the London area; to organise an abstract service and to collect data from research staff for compilation into reports and publicity pamphlets. Salary £500–£850 according to experience. Box 712, T. G. Scott & Son, Ltd., 9 Arundel Street, London, W.C.2.

Metallurgist and Physical or Inorganic Chemist required in modern research laboratory near London for work involving reaction of molten metals and fluxes. Only men with first-class qualifications are required. Salary according to experience. Box 713, T. G. Scott & Son, Ltd., 9 Arundel Street, London, W.C.2.

MICROANALYST required by organic microanalytical laboratory. Candidates should hold an honours degree or A.R.I.C. and should have had experience in standard micro-organic elemental and group determinations. Commencing salary of the order £400–£450 per annum depending on experience. Apply to Technical Director, Genatosan, Ltd., Loughborough, Leics.

Paint Chemist required for large oil Laboratory in the London area. Must have good University degree. Age under 30. At least 2 years experience with an industrial paint firm essential. Permanent position. Salary according to age, qualifications and experience, details of which please supply, also when available, to Box 714, T. G. Scott & Son. Ltd., 9 Arundel Street, London, W.C.2.

University of London King's College requires an Assistant Lecturer in Electrical Engineering. Candidates should have a good Honours Degree and have had practical experience in the field of Electrical Power or Electrical Machinery. Salary £400 p.a. Particulars and forms of application from the Secretary, King's College, Strand, W.C.2, whom final applications must reach by November 9.

Technical Assistant required for University Physics Department for construction and maintenance of teaching and research equipment. Permanent post, good prospects, child allowance, pension scheme, salary according to age and experience. Interest in practical physics essential, experience instrument making and/or vacuum electronics desirable. Apply, quoting FAV, Professor of Physics, University, Manchester, 13.

Librarian required for special technical library at new Research Association's H.Q., soon to be established at Melton Mowbray, Leicestershire. Must have A.L.A. or experience in special library. Full particulars to Information Manager, Production Engineering Research Association, Frederick Street, Loughborough, Leicestershire.

Chemist, young graduate required as assistant in research department of North East smelting works. A sound chemical knowledge and some industrial research experience is essential. Write giving full particulars of qualifications and experience to the Managing Director, The Cookson Lead and Antimony Co., Ltd., Crescent House, Newcastle-upon-Tyne, 1.

Bacteriologist (man) required immediately to initiate investigations in the Research Laboratory in London of a company manufacturing antiseptics, etc. Wide experience in Bacteriology primary qualification. Salary will be in accordance with qualifications and experience. Pension scheme is in operation. Apply, with full particulars of qualifications and experience, together with names of two referees, to Box 722, T. G. Scott & Son, Ltd., 9 Arundel Street, London, W.C.2.

Biochemist required to control section of research laboratory working on yeast metabolism, microbiological assays, etc. Salary according to qualifications and experience but not less than £700 p.a. Box 719, T. G. Scott & Son, Ltd., 9 Arundel Street, London, W.C.2.

Graduate in general biology required to assist in research on the culture and breeding of yeasts; knowledge of bacteriology, genetics, microscopy and micromanifestation an advantage but not essential. Salary according to qualifications and experience. Box 720, T. G. Scott & Son, Ltd., 9 Arundel Street, London, W.C.2.

Laboratory Steward (male or female) required for the Chemistry Department of Wye College (University of London). Some experience essential. Salary not less than £300 per annum. Apply immediately to the Secretary, Wye College, near Ashford, Kent.

Biology. Assistant required with experience in dissection of Laboratory Types for display. Good opportunity for keen worker. Apply by letter only, stating age, wage, etc., to Flatters & Garnett, Ltd., 309, Oxford Road, Manchester, 13.

The Research Department of the Cambridge Instrument Co., Ltd., Cambridge, has a vacancy for an Assistant Chemist (graduate), with some experience of chemical analysis of metals, and with ability to construct his own apparatus. Applicants should write, giving details of education, experience and salary required.

Chemist required, University degree, for manufacture of fine organic chemicals. Age preferably below 30. Salary between £300 and £400 progressive. Apply Box 721, T. G. Scott & Son, Ltd., 9 Arundel Street, London, W.C.2.

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on reclaimed upland areas in Montgomeryshire are described, in which re-seeding appears to have considerably improved the carrying capacity of the land. Practical advice on silage-making and its place in good grassland management is the subject of a further article, silage both being a valuable food and a useful means of controlling the sward and, moreover, not entailing heavy capital outlay or expensive equipment. From a detailed account of severe leather-jacket attack on re-seeded grassland in Yorkshire, there seems at present no really efficient means for controlling this pest on a farm scale, though attention to drainage, close grazing during the late summer when egg-laying takes place, and the maintenance of fertility are evidently factors which may lessen the degree of attack. A feature of this first number are the good photographs which illustrate each of the articles.

Japanese Men of Science in Malaya during the War

Dr. H. E. Desch writes to state that he wishes to make it clear that he does not endorse the conclusions and inferences to be drawn from Mr. E. J. H. Corner's letter on this subject which appeared in *Nature* of July 13. He is not prepared to enter into a lengthy correspondence, but directs attention to on e point of fact. The format of Symington's "Foresters' Manual of Dipterocarps" was in no way determined or influenced by the Japanese; it was already in page proof before the Malayan campaign, and half the page formes survived the effects of blast from demolitions adjacent to the Caxton Press works. Because of this fact, Mr. Lebroy of the Caxton Press reset the remainder of the work and printed the whole for a figure that the Japanese ultimately accepted. Re-setting was done from a galley proof handed to Dr. Desch by Mr. Symington's Malay assistant.

Mathematics at University College, Southampton: Prof. E. T. Davies

Dr. E. T. Davies, who has just been appointed to the chair of mathematics at University College, Southampton, is one of the outstanding leaders of research in modern differential geometry. He graduated at the University College of Wales, Aberystwyth, in 1925, and was awarded a research studentship which took him to Rome to study under Levi-Civita. The next two years he spent working under Cartan at the Sorbonne. His researches in Rome and Paris under two great geometers had a decisive influence on his future work. Since 1930 he has been lecturing at King's College, London, and has been developing a fertile and original field of research which may be generally described as resulting from the action and reaction of differential geometry and the calculus of variations. He has studied problems of deformation of sub-spaces, of 'imbedding', of automorphism, and of the variation of multiple integrals. His later papers give a unified treatment of all geometries having a vector density as element of support, and thus generalize the work of Carton and Finsler. His new appointment, which he takes up at the beginning of 1947, will give him the opportunity to build up a school of research workers in this interesting and important field.

University of London: Appointments

The following appointments recently made by the University of London have been announced: Dr. Frank Dickens, during 1933–46 research director for the North of England Council of the British Empire Cancer Campaign, to the Philip Hill chair of experimental biochemistry tenable at the Middlesex Hospital Medical School as from March 1, 1946; Dr. J. F. Danielli, during 1942–45 research fellow and supervisor in physiology at St. John's College, Cambridge, to the University readership in cell physiology, tenable at the Royal Cancer Hospital as from October 1, 1946; Dr. J. L. D'Silva to the University readership in physiology tenable at St. Bartholomew's Hospital Medical College, where he has been lecturer in physiology since March 1944; Dr. J. M. Robson, senior lecturer in pharmacology in the University of Edinburgh, to the University readership in pharmacology tenable at Guy's Hospital Medical School as from October 1, 1946. The title of reader in applied entomology in the University of London has been conferred on Dr. A. B. P. Page in respect of the post held by him at the Imperial College of Science and Technology.

University of Glasgow: Appointments

The following appointments have been made in the University of Glasgow: John E. Parton and Douglas S. Gordon to be lecturers in electrical engineering, and A. J. O. Cruickshank as an assistant; John S. Macpherson, W. A. Donaldson and D. D. McKinnon to be assistants in mathematics; and Robin Giles as an assistant in natural philosophy.

University College, Hull: Appointments

University College, Hull, has made the following promotions and appointments in the Faculty of Science: Paul G. 'Espinasse to be professor of zoology; R. D'O. Good to be professor of botany; Dr. B. Jones to be G. F. Grant professor of chemistry in succession to Prof. F. G. Tryhorn; Dr. B. T. Cromwell to be reader in botany; Miss M. A. Tazelaar to be lecturer in zoology. The following have been appointed assistant lecturers: J. W. F. Bell (physics), D. P. Brachi (geography), Dr. A. Cunliffe (physics), Miss L. R. Latham (geography), Mrs. H. Neumann (mathematics), E. R. Trueman (zoology), J. Webster (botany). A. Saville has been appointed research biologist in the Department of Oceanography.

Announcements

The following appointments have recently been made by the Colonial Office: A. B. Briars, to be agricultural officer, Nyasaland; J. F. Graham, to be supernumerary entomologist, East African Locust Directorate, Kenya; A. D. T. Montague, agricultural officer, Gold Coast, to be senior agricultural officer, Gold Coast; R. O. Roberts, geologist, Uganda, to be chemist and petrologist, Uganda.

Mr. J. A. Young has been appointed assistant agricultural adviser to the High Commissioner for the United Kingdom in Canada, and will be stationed at Ottawa. He will assist in that capacity Mr. A. N. Duckham, the agricultural adviser to the High Commissioner, who is also the agricultural attaché at the British Embassy in Washington. Mr. Young was educated at Dungannon Royal School and Queen's University, Belfast, where he obtained the degree of B.Agr., with distinction. After leaving the University he was appointed to the inspectorate of the Ministry of Agriculture for Northern Ireland and latterly has been mainly engaged on technical and agricultural education work.

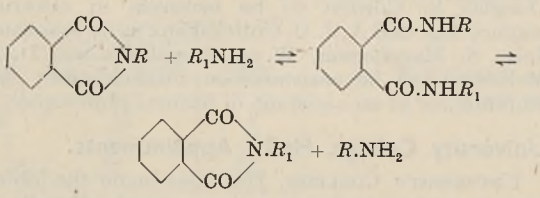
LETTERS TO THE EDITORS

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

Composition of the Antimalarial Drug *R*.63 and the Ing and Manske Hydrazine Hydrolysis of N-Substituted Phthalimides

DURING 1944, we investigated, as part of our antimalarial research programme, the structure of the potent antimalarial drug *R*.63[1]. The recent publication by Mosher[2] of a further contribution to this subject makes it desirable to report briefly our own results. Some of this work forms the subject-matter of a British Patent Application (17071/44, of September 6, 1944) which was placed on the secret list, thus delaying publication. It is clear that Mosher has independently reached the same conclusion as our own, namely, that *R*.63 contains a substantial proportion of *R*.36 (8-*γ*-aminopropylamino-6-methoxyquinoline dihydrochloride).

Our preliminary experiments soon indicated that *R*.63 was a complex mixture, and we therefore approached the problem mainly by a study of the reactions involved in its preparation, in preference to attempting a complete analysis of *R*.63 with few clues to the nature of the probable constituents. In our preparations of *R*.36 by the hydrolysis of 8-*γ*-phthalimidopropylamino-6-methoxyquinoline with alcoholic hydrazine hydrate[3], we have found that a secondary product, *bis*-[*γ*-(6-methoxy-8-quinolylamino)propyl]-phthalamide, is formed in amounts depending on the proportion of hydrazine hydrate used (30 per cent theoretical quantity with 0·8 molecular proportion of hydrazine hydrate). The discovery of this by-product led eventually to the following scheme of reactions between N-substituted phthalimides and amines being established.

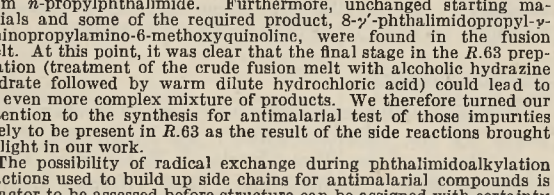


The main factors which determine the end products are the electronic characteristics of *R* and R_1 and such relevant properties as solubility of their derivatives in the reagents used, or volatility at the reaction temperature.

When the penultimate stage of the preparation of *R*.63 (the fusion of 8-*γ*-aminopropylamino-6-methoxyquinoline and *γ*-bromopropyl phthalimide) was considered in the light of the above scheme, it was possible to explain such unexpected results as the isolation from the reaction product of some 8-*γ*-phthalimidopropylamino-6-methoxy quinoline (I)—a result confirmed but not explained by Mosher. The isolation of (I) implied the simultaneous formation of the highly reactive bifunctional compound, *γ*-bromopropylamine, which would immediately undergo self-condensation or react with other components of the reaction mixture. Evidence for this view was found in a model experiment in which *n*-propylamine was in fact liberated from *n*-propylphthalimide. Furthermore, unchanged starting materials and some of the required product, 8-*γ*′-phthalimidopropyl-*γ*-aminopropylamino-6-methoxyquinoline, were found in the fusion melt. At this point, it was clear that the final stage in the *R*.63 preparation (treatment of the crude fusion melt with alcoholic hydrazine hydrate followed by warm dilute hydrochloric acid) could lead to an even more complex mixture of products. We therefore turned our attention to the synthesis for antimalarial test of those impurities likely to be present in *R*.63 as the result of the side reactions brought to light in our work.

The possibility of radical exchange during phthalimidoalkylation reactions used to build up side chains for antimalarial compounds is a factor to be assessed before structure can be assigned with certainty to the products obtained.

A further interesting feature which also emerged was the nature of the intermediate formed in the hydrazine hydrolysis of N-substituted phthalimides (II). Ing and Manske[4] tentatively assigned the structure (III) to the product, but did not isolate and characterize it in any one case.



(II) (III) (IV)

We have found that the product is in fact the *salt* of the base, *R*.NH_2, with phthalyl hydrazide (IV), which is a moderately strong acid. The recognition of the nature of this intermediate (foreshadowed by Mosher, *loc. cit.*) shows at once that the subsequent acid hydrolysis is an irrelevant step, and improvements in the method which may widen its application are apparent. Thus, the required base can be obtained by thermal dissociation, by solvent extraction or by basification of the intermediate salt. An interesting new application of phthalyl hydrazide is the preparation of anhydrous hydrazine by thermal dissociation of the readily accessible hydrazine salt of phthalyl hydrazide[5]. Other volatile bases may be treated similarly.

A fuller account of this work will appear elsewhere in due course.

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Kinetics of Aromatic Nitration: the Nitracidium Ion

THE kinetic studies described in the first of these communications* lead to the conclusion that the nitracidium and nitronium ions, H_2NO_3+ and NO_2+, are successively formed during nitration by nitric acid, but that only the nitronium ion, NO_2+, is effective for nitration in anhydrous or nearly anhydrous acid. This note offers evidence for the effectiveness, under other conditions, of the nitracidium ion, H_2NO_3+, as a nitrating agent.

We should expect to be able to provide such evidence, if at all, only by operating in aqueous media. For it has been shown that in anhydrous nitric acid, as well as in other anhydrous strong acids, any H_2NO_3+ formed is largely or completely dehydrated to NO_2+; and we can be certain that, whenever any appreciable quantity of NO_2+ is present, it, rather than H_2NO_3+, will be the effective agent for nitration.

We have accordingly pursued the study of nitration kinetics into the range of media in which the main constituent is water, though the concentration of nitric acid has to be such that this substance is largely present as molecules, and not almost wholly as nitrate ions. Under these conditions nitration is invariably (within our experience) a reaction of the first order with respect to the aromatic compound: comment on this is made below. Further, the reaction is accelerated by added strong acids, such as perchloric or sulphuric acid: this shows that the nitric acid molecule itself is not the nitrating agent, and that a proton uptake must in some way be involved. Finally, nitration is retarded by added nitrate ions, and this is not a primary salt effect. All these results point to the formation of the nitracidium ion in pre-equilibrium,

$$2HNO_3 \rightleftharpoons H_2NO_3^+ + NO_3^-,$$

and they are consistent with the hypothesis that this ion is the nitrating agent.

The kinetic results do not rigorously exclude the possibility that the nitracidium ion is further converted into the nitronium ion, and that the latter is the nitrating agent. There are, however, two arguments against this interpretation. One is that our knowledge of the properties of the NO_2+ ion make it very difficult to believe that any trace of it could exist in a medium containing 70 mol. per cent of water. The other is that, if the NO_2+ ion were an intermediary, we might have hoped to observe a zeroth-order reaction, for which, actually, we have made a prolonged but unavailing search. We have evidence that the nitracidium ion may also become the effective agent for the *N*-nitration of amines[1].

The main series of experiments have been carried out with sodium toluene-*ω*-sulphonate. Because of the small nitrating power of solutions such as those here used, it is necessary to employ reactive aromatic compounds, which must, moreover, be soluble in water. Phenol and aniline derivatives had to be avoided, because special complications are liable to arise in these cases.

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* *Nature*, **158**, 448 (1946).
[1] Unpublished investigations with J. Glazer.

Nitration of Phenol and Aniline Derivatives: Role of Nitrous Acid

WHILE nitrous acid (we include in this term all material that with water gives nitrous acid) is a negative catalyst in aromatic nitration generally, it has often been found to be a positive catalyst in the nuclear nitration of phenol and aniline derivatives. New experiments, mainly with phenol derivatives, have lessened the contrast by showing that, in the nitration of these substances, both positive and negative catalysis may be encountered in different ranges of nitric acid concentration, and that the negative catalysis is quite similar to that appearing in the nitration of aromatic compounds of other types. Nevertheless it is clear that certain special mechanisms, dependent on nitrous acid, intervene in the nitration of phenol and aniline derivatives, and we have been attempting to throw some light on their nature by a study of the kinetics and products of the nitration of these compounds.

The following is a composite kinetic picture based on studies with phenol, *o*- and *p*-nitro- and 2:4-dinitro-phenol, anisole, *p*-cresyl methyl ether and diphenyl ether, mainly in acetic acid as solvent. Parts of the pattern become repressed, and other parts accentuated, for aniline derivatives. For fixed concentrations of nitrous acid, an increasing concentration of nitric acid at first retards, then strongly

accelerates, and then retards reaction, the final phase setting in the earlier the higher the nitrous acid concentration. For fixed concentrations of nitric acid, an increasing concentration of nitrous acid at first strongly accelerates, then retards, and then weakly accelerates nitration, the retardation setting in the earlier the higher the concentration of nitric acid. These statements apply to the general conditions investigated, in which the concentration of nitrous acid was shown to remain constant during nitration.

The detailed presentation and analysis of these relations would be lengthy; but we may state our conclusions. They are, first, that nitric acid is doing three things: it is producing a strong nitrating agent (NO_2+); it is converting the aromatic compound into a nitration-resisting oxonium ion; and it is helping nitrous acid to suppress NO_2+ (by converting N_2O_4 into ions, in particular nitrate ion, as described in the first of these communications*). Secondly, nitrous acid is also doing three things: it is uniting with the phenol derivative to form a complex, which is highly reactive in nitration; it is, as already mentioned, co-operating with nitric acid to produce nitrate ion and thus to suppress NO_2+; and, in the form N_2O_4 (or $2NO_2$), it is itself acting as a direct nitrating agent.

We think the complex may depend on univalent electron exchange[1]. Veibel[2] has already postulated an addition complex between phenol and nitrous acid. Arnall[3] has previously assumed direct nitration by N_2O_4.

With phenols, especially in aqueous solvents containing much nitrous acid, yet another mechanism enters, which has been considered before[2,4], namely, nitrosation with subsequent oxidation. Our main evidence of this is that whereas phenol on nitration in water in the presence of as little nitrous acid as possible (PhOH = 1, HNO_3 = 1, HNO_2 = 0 mol.) yields *o*- and *p*-nitrophenols in the approximate proportions 7 : 3, in the presence of a large amount of nitrous acid (for example, PhOH = 1, HNO_3 = 1, HNO_2 = 2 mol.) the ratio becomes changed to 1 : 9, and this is the ratio in which *o*- and *p*-nitrosophenols are formed if the nitric acid is omitted[2]. *p*-Nitrosophenol has been isolated as a by-product from the latter nitrations.

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* *Nature*, **158**, 448 (1946).

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Organic Nitrogen Compounds as Nitrogen Nutrition for Higher Plants

In sterile cultures pea and clover use especially well aspartic and glutamic acids for their nitrogen nutrition, as demonstrated by previous experiments in this laboratory[1]. Both the optical forms are utilized[2]. If the nutrient solution contains aspartic acid as well as nitrate and ammonium sulphate, all these nitrogen sources are utilized simultaneously (see accompanying table). Aspartic acid thus competes with nitrate and ammonium nitrogens as a nitrogen source for peas, an important fact to be borne in mind when discussing the ability of plants to utilize organic nitrogen in natural conditions. Nitrogen nutrition has a marked effect on the structure of pea roots. Peas grown on nitrate nitrogen and without nitrogen form in this respect a special group; peas grown on aspartic acid nitrogen, on ammonium nitrogen and on nitrogen supplied by root nodules another.

Furthermore, we have confirmed the earlier observations that when the pea uses aspartic acid for its nitrogen nutrition, nitrogen and carbon disappear from the solution in the same proportion[3] and that no essential change occurs in the *p*H of the solution and no ammonia can be detected in the nutrient solution. In aspartic acid the ratio of carbon to nitrogen is 3·43; in the nutrient solution which originally contained 50 mgm. aspartic acid nitrogen and at the end of the experiment 16·6 mgm. nitrogen (all the remaining nitrogen being amino nitrogen) the amount of organic carbon was 57·8 mgm.; accordingly the ratio C/N = 3·48. The position was the same, when the nutrient solution contained besides aspartic acid also nitrate. The ratio of C to NH_3–N in the nutrient solution was thereby likewise 3·48. The results confirm the previous investigations of this laboratory which were interpreted by assuming that the whole aspartic acid molecule is being utilized. Not until it reaches the root cells does the transformation of aspartic acid take place (through deamination, transamination, etc.).

With plants of the family Gramineæ (wheat and barley as test plants) aspartic and glutamic acids do not function as N-source according to the previous findings of this laboratory[1]. The entirely different behaviour of legumes and non-legumes towards amino dicarbonic acids is especially noteworthy since certain other amino-acids, for example, α-alanine and glycocol, are utilizable also by wheat and barley. In our new experiments, very similar results have been obtained as in the previous ones. In one experiment the wheat grown in different nitrogen nutrition media contained the following amounts of nitrogen: without nitrogen nutrition 3·2 mgm., on aspartic acid 2·9 mgm., on glutamic acid 3·3 mgm., on nitrate 22·2 mgm., on glycocol 10·5 mgm., on α-alanine 6·8 mgm., on cystine 7·6 mgm. The amount of nutrient solution was in all experiments 20 mgm. per plant. Some other amino-acids were taken up in certain degree, but in spite of that no growth occurred which would have resulted in the rise of dry matter yield. Aspartic and glutamic acids which in some experiments were taken up in very small amounts, 1–2 mgm. nitrogen per plant, lower appreciably the dry weight of plants. Evidently they accelerate respiration. Since the transamination takes place in Gramineæ as easily as in leguminous plants (our results in this respect are in good agreement with those of Cedrangolo and Carandante[4]), the ineffectiveness of aspartic and glutamic acids is difficult to explain.

Moreover, it has been noted that if the wheat is given in sterile nutrient solution besides aspartic acid also nitrate and ammonium sulphate (each providing 22 mgm. nitrogen, total nitrogen supply per plant 66 mgm.) the wheat does not grow. The cause for this is being investigated.

Regarding the utilization of amino-acids other than aminodicarbonic acids by leguminous plants it may be mentioned that the utilization of glycocol by pea is noticeably good. α-Alanine is utilized to a certain extent, but it often causes a curious branching and shortening of internodes. The growth of pea is comparatively good on hydrolysed casein (HN_3 removed) and Witte pepton.

In the light of our laboratory experiments, especially the new ones regarding the favourable competition of some amino-acids with nitrate and ammonia nitrogen, it seems probable to us that in natural conditions plants use also organic nitrogen compounds for their nitrogen nutrition, at least in certain soils. As a rule, however, the uptake of organic nitrogen by cultivated plants is not great, since ammonium salts and nitrates are rapidly formed from organic nitrogen compounds in soil. Since, however, the uptake of organic nitrogen compounds even in small amounts may affect the plants markedly, the significance of these nitrogen compounds can be great. In the foregoing, alanine has been noted to cause pronounced changes in the shape of pea, and phenyl ethylamine, the decarboxylation product of phenylalanine, which has been added to nitrate-containing nutrient solution, has produced a branching of different type in pea. Effects of this kind can be expected to occur under certain conditions also in Nature.

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Botanical Origin of Tube-Curare

dextro-Tubocurarine chloride was first isolated in crystalline form from native tube-curare[1]. It has since become a valuable adjunct in anæsthesia[2]. The chemical constitution of *dextro*-tubocurarine chloride and its relation to bebeerine[3] suggests that its botanical origin lies in some species of *Chondrodendron*. Through the kindness of Mr. J. W. Massey, British consul in Iquitos, the stem and leaves of *Chondrodendron tomentosum* Ruiz and Pavon, collected by the late Guillermo Klug at Tarapoto in Peru, have been made available. The leaves were identified by Mr. N. Y. Sandwith of the Herbarium, Kew, as belonging to this species, and on chemical examination the stems yielded *lævo*-curine (*l*-bebeerine) and *lævo*-tubocurarine chloride. The latter was found by Dr. B. D. Burns to have a curare action on the rat's diaphragm, which was very weak when compared with that of *dextro*-tubocurarine chloride.

On the other hand, Dutcher[4] has examined a native Upper Amazonian curare prepared from *Ch. tomentosum* and has isolated *dextro*-tubo-

Torsdag-pea grown on different N-nutrition in sterile water cultures. One plant in each flask containing 1 l. nutrient solution. Sterile plants were transferred to culture flasks January 19–21, 1946.

Quality of N-nutrition	$(NH_4)_2SO_4$ + $Ca(NO_3)_2$ + Aspartic acid				$Ca(NO_3)_2$ + Aspartic acid				$(NH_4)_2SO_4$ + Aspartic acid	
Amount of N-nutrition, N (mgm.)	50 + 50 + 50 = 150				50 + 50 = 100				50 + 50 = 100	
Number of days N-nutrition given	14	22	28	35	14	22	28	35	22	38
Dry weight of plant (mgm.)	919	1789	2589	2987	857	1989	1823	2792	487	688
N in plant (mgm.)	48·3	86·6	108·7	118·9	38·9	61·2	49·8	64·3	27·9	42·4
N in % of dry matter	5·2	4·9	4·0	4·0	4·5	3·1	2·7	2·3	5·7	6·2
Final *p*H of the nutrient soln.	6·1	6·1	6·5	6·8	6·9	6·9	7·5	7·4	6·3	6·0
NO_3—N used (mgm.)	10·8	23·1	25·8	26·0	19·6	33·1	26·2	37·4		
NO_3—N in % of total N used	22·8	28·6	24·2	22·4	55·7	61·1	54·8	63·7		
NH_4—N used (mgm.)	16·5	31·5	40·8	49·0					13·6	21·2
NH_4—N in % of total N used	34·9	39·1	38·2	42·1					69·4	53·1
NH_3—N used (mgm.)	20·0	26·0	40·0	41·3	15·6	21·1	21·5	21·3	6·0	18·7
NH_3—N in % of total N used	42·3	32·3	37·6	35·5	44·3	38·9	45·2	36·3	30·6	46·9
Total used N (mgm.)	47·3	80·6	106·6	116·3	35·2	54·2	47·7	58·7	19·6	39·9

curarine chloride, *lævo*-curine and other non-quaternary bases. It therefore seems that the species named *Ch. tomentosum* may include two hitherto undifferentiated species needing the attention of the systematic botanist.

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Molybdenum-Thiocyanate Complex

WHEN stannous chloride is added to an acid solution containing molybdenum and an alkali thiocyanate an orange coloration appears. This reaction has been applied as the basis of methods for the determination of molybdenum in steels[1,2,3], soils[4], rocks[5], and plant materials[6].

The reaction was first observed by Braun[7], who gave some indication of the sensitivity of the test and noted also that the coloured complex was freely soluble in ether and could, therefore, be concentrated in this solvent.

We have investigated this reaction for the determination of small amounts of molybdenum in biological material, and the details of the modifications we have introduced will be published elsewhere. However, in the course of the investigation we have found that the density of colour developed from a fixed amount of molybdenum is dependent upon the presence of iron in the solution.

If a colour density/molybdenum concentration curve is constructed from transmission readings on extracts of the coloured complex in iso-amyl alcohol, which we found to be the most satisfactory solvent, it is seen that a straight line relationship is not obtained when the extracts are first prepared. If, however, further readings are taken after the extracts have been standing in open tubes for some time, the density/concentration curve progressively approaches linearity, until after a period of some ten days or so the colour density is directly proportional to molybdenum concentration. These results are illustrated in Fig. 1.

On the other hand, if sufficient iron is present in the aqueous molybdenum solution, there is no intensification of the colour as was observed in the absence of iron. The density of the colour is proportional to the molybdenum concentration immediately the extracts are prepared, and the colour remains stable over long periods.

If the coloured complex is developed from a fixed amount of molybdenum in the presence of varying amounts of iron, one finds that the colour density is greater with increasing amounts of iron until a certain minimal quantity of iron has been added, and then remains practically constant. This effect is shown in Fig. 2, which records the results of three experiments at three different levels of molybdenum, and it will be seen that the amount of iron required for full colour development increases as the amount of molybdenum present increases. We found that 10, 20 and 30 μgm. of molybdenum require 6, 12 and 18 μgm. of iron respectively for full colour development. That is, one gram atom of iron is required for each gram atom of molybdenum.

However, although the presence of iron intensifies the colour it does not modify the nature of the colour, for spectral absorption curves in the presence and absence of iron are identical.

A quantitative study shows that the density of the colour produced from a given amount of molybdenum per cent in the absence of iron is approximately 65 per cent of that produced when adequate iron is present. It seems probable, from the above observations, that the complex molecule consists of a chromogenic and a non-chromogenic part and that, in the absence of iron, some of the molybdenum is present in each part of the molecule. We suggest that the action

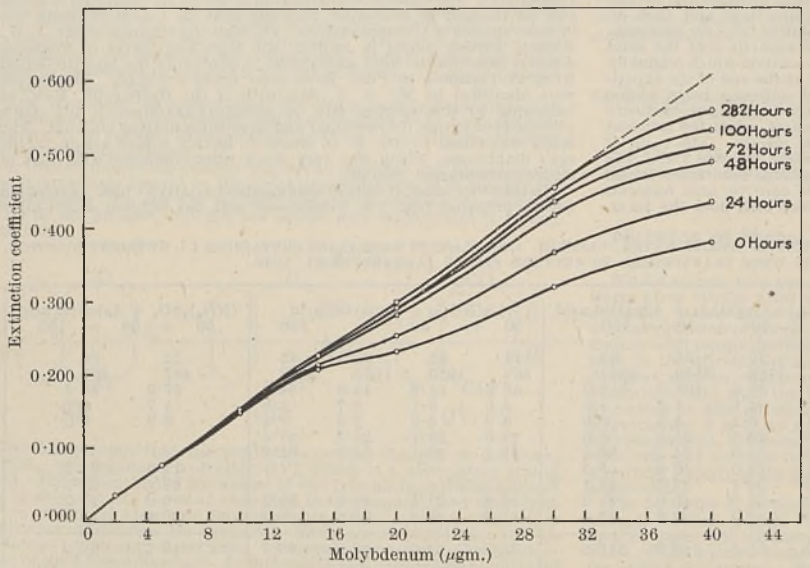

Fig. 1. INTENSIFICATION OF 'MOLYBDENUM THIOCYANATE COMPLEX' IN AMYL ALCOHOL

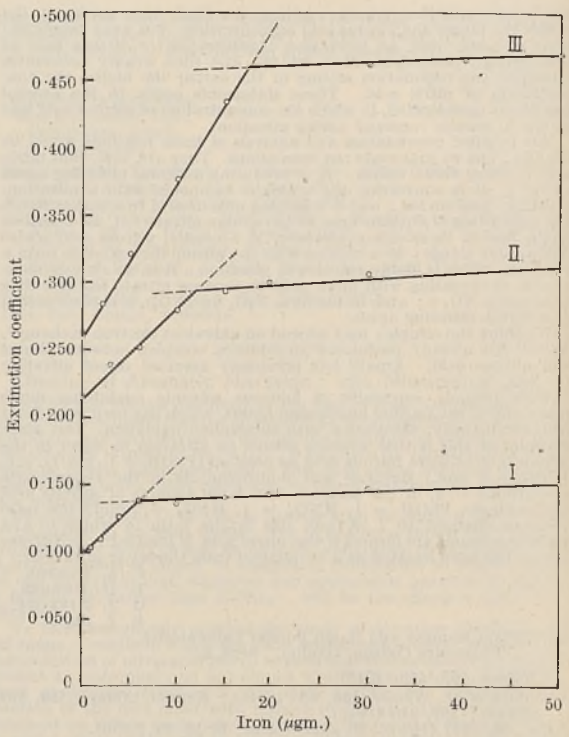

Fig. 2

of iron is to replace the molybdenum in the non-chromogenic part of the molecule, and we would formulate the complex, under the two conditions, as follows:

In the absence of iron $Mo_2[MoO(CNS)_5]_3$
In the presence of iron $Fe[MoO(CNS)_5]$.

In a study of the properties of the molybdenum thiocyanate complex in aqueous solution, Hiskey and Meloche[8] conclude that the molybdenum in the coloured complex is quinquevalent, that the ratio of thiocyanate to molybdenum is 3 : 1, and that tervalent molybdenum does not form a red-coloured thiocyanate. The above formulation is in accord with all these observations. If only that portion of the complex within the square brackets is regarded as chromogenic, then the molybdenum is quinquevalent, that outside the bracket is tervalent and non-chromogenic. This formulation also allows for the observed one third intensification of the colour when all the molybdenum is moved into chromogenic part of the molecule as in the presence of iron.

Recently, Shashkov[9] has published some findings on the nature of the molybdenum-thiocyanate complex in aqueous solution. He found that the slope of the colour density/molybdenum concentration curves varied for different ranges of molybdenum concentration and suggested that the complex formed with the lower concentrations was different from that formed with the higher. It is probable that Shashkov's two complexes correspond to those formulated above. If his reagents contained traces of iron, then the intensification due to the formation of the iron-containing complex would increase the slope of the density/concentration curves at the lower concentrations of molybdenum but would have little effect in the higher concentrations, as only a small proportion of the total coloured complex would be in the iron-containing form.

Of eighteen other elements investigated, namely, sodium, silicon, potassium, calcium, titanium, vanadium, copper, chromium, manganese, cobalt, nickel, zinc, arsenic, silver, tin, antimony and mercury, copper alone had any similar effect. Curves constructed showing the effect of varying amounts of copper on the colour density with a fixed amount of molybdenum were similar in form to those represented for iron. The points of inflexion corresponded to a ratio of 3 gm. atoms of copper for every 4 gm. atoms of molybdenum, showing that rather less copper than iron is needed to effect full colour development.

We feel that attention should be directed to these observations since any procedure for the determination of molybdenum by the thiocyanate method, which compares the colour produced in the sample, which

may contain adequate iron, with that obtained from a standard solution of molybdenum to which no iron or copper has been added, must give high results. This can readily be obviated by the addition of sufficient iron or copper to both standard and sample.

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Abnormal Solar Radiation on 72 Megacycles

THE suggestion that the sun emits energy at a rate in excess of the black-body value on radio wave-lengths during periods of sunspot activity has been made by Appleton[1]. Experimental evidence of this effect has been obtained by Hey[2], and Pawsey, Payne-Scott and McCready[3]. Details are given here of measurements of the intensity of some extremely large increases of radiated solar energy on 72·6 Mc./s. observed during July and August 1946. The equipment was not primarily designed for measurements of solar radiation and was engaged on other experiments using a vertically directed aerial system. In calculating the solar radiation intensity, allowance has therefore been made for the polar diagram of the aerial system and the position of the sun.

At this frequency the flux density of black-body solar energy between frequencies f and $f+\triangle f$ received at the earth's surface is given by[1]:

$$F = \frac{2\pi kT}{\lambda^2}\left(\frac{r}{R}\right)^2 \Delta f \text{ ergs/cm.}^2\text{/sec.},$$

where r is the sun's radius, R the earth-sun distance, k Boltzmann's constant and T the effective solar temperature. If this energy is received on an aerial of power gain G over a half-wave dipole, the equivalent collecting area is approximately $G\lambda^2/8$, and the solar black-body radiation will give a power p_s at the receiver where:

$$p_s = 0{\cdot}4\, G.k.T.\left(\frac{r}{R}\right)^2 \Delta f \text{ ergs/sec.}$$

In the present equipment, $G = 7{\cdot}8$, and the band-width of the receiver $\triangle f = 2{\cdot}5 \times 10^5$ c.p.s. Hence, if $T = 6{,}000°$ K., $p_s = 1{\cdot}4 \times 10^{-18}$ watts (corresponding to a radiation intensity of $6{\cdot}5 \times 10^{-29}$ watts/cm.^{2}/c.p.s. (band-width).

The normal noise-level of the receiver corresponded to a power input p_r of $2{\cdot}7 \times 10^{-14}$ watts (equivalent to a radiation intensity of $1{\cdot}25 \times 10^{-24}$ watts/cm.^{2}/c.p.s. band-width). Hence an increase of solar energy of $1{\cdot}9 \times 10^4$ over its black-body value would be necessary before the effect became noticeable. This level was exceeded over a considerable period, and at one stage the solar radiation intensity reached $8{\cdot}6 \times 10^{-21}$ watts/cm.^{2}/c.p.s. band-width, that is, $1{\cdot}3 \times 10^8$ times the normal black-body value.

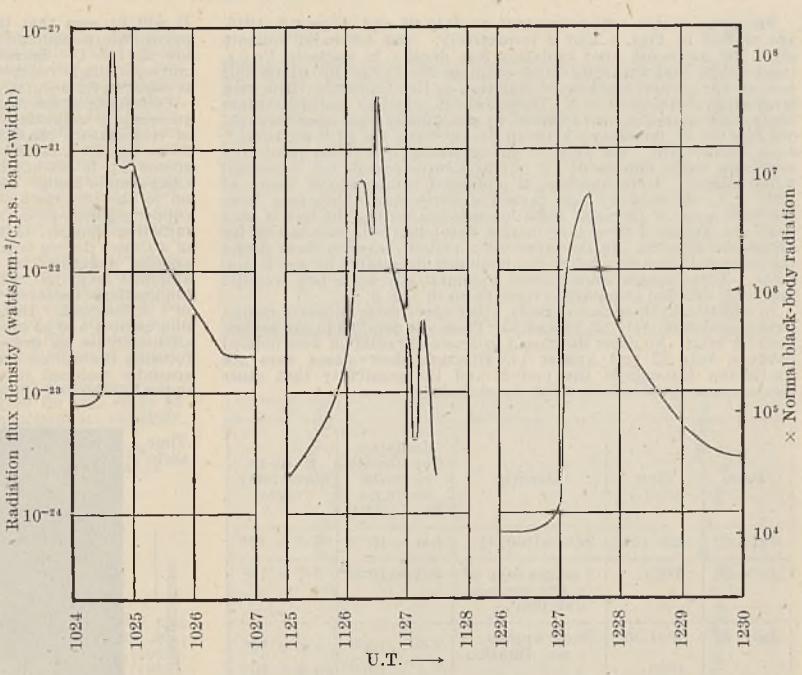

Fig. 2. SHORT-PERIOD PEAKS ON AUGUST 2.
Details as for Fig. 1

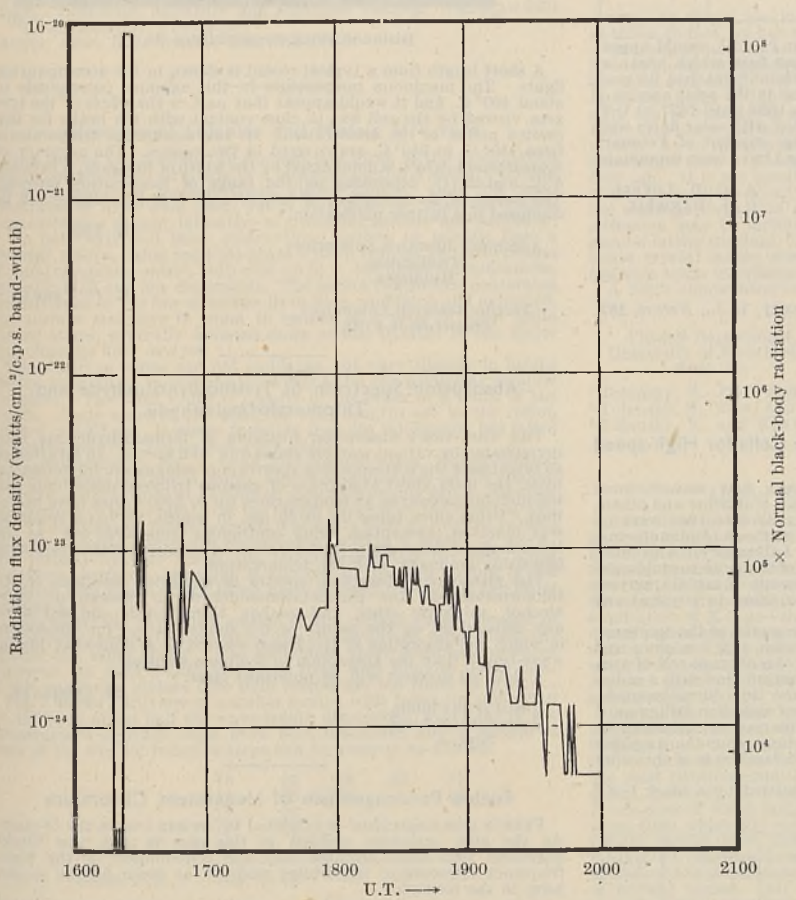

Fig. 1. SOLAR RADIATION ON 72·6 MC./S. ON JULY 25
Polarization of aerials horizontal; elements of aerial, north – south; point of observations, lat. 53° 13′ 53″ N., long. 2° 18′ 11″ W.

The main events, which occurred on July 25 and August 2, 1946, are plotted in Figs. 1 and 2 respectively. The left-hand ordinate gives the measured solar radiation flux density in watts/cm.²/c.p.s. band-width, and the right-hand ordinate the factor by which this exceeds the normal black-body radiation on this frequency. The very large surge of energy at 1624 U.T. on July 25, which exceeded 10^6 times black-body radiation, was followed by abnormally high noise throughout July 26–27, fluctuating between 6×10^{-23} and 8×10^{-23} watts/cm.²/c.p.s. band-width. On July 28 the radiation had fallen below the minimum value detectable by our apparatus except for occasional minor surges. Unfortunately, a prolonged thunderstorm began at 1200 U.T. on July 26 and caused disturbances which may have obscured some of the solar radiation maxima during the rest of that day. On August 2 three large surges were observed, each lasting for about two minutes. In the intervening periods between these surges the solar radiation was below the minimum detectable by our equipment. These surges were plotted automatically by a pen recorder and their detailed structure is reproduced in Fig. 2.

In addition to these main events, other appreciable surges of energy were recorded on July 22, 24 and 25. These are detailed in the accompanying table. No other significant increases of radiation were noticed between July 22 and August 14, although observations were not continuous throughout the period, and the possibility that other surges occurred cannot therefore be excluded.

Date	Time (U.T.)	Remarks	Radiation flux density in watts/cm.²/c.p.s. band-width	Ratio to black-body value
July 22	1629–1642	Several surges	$5{\cdot}0 \times 10^{-24}$	$7{\cdot}7 \times 10^4$
July 24	1628	3 surges each of a few seconds duration	$5{\cdot}0 \times 10^{-24}$	$7{\cdot}7 \times 10^4$
July 25	1031.30	Surge approx. 1 sec. duration	$3{\cdot}8 \times 10^{-23}$	$5{\cdot}8 \times 10^5$
,,	1032	,, ,,	$3{\cdot}8 \times 10^{-23}$	$5{\cdot}8 \times 10^5$
,,	1434	Surge approx. 2 sec. duration	$5{\cdot}6 \times 10^{-23}$	$8{\cdot}6 \times 10^5$
,,	1435.30	Surge approx. 0·5 sec. duration	$5{\cdot}4 \times 10^{-24}$	$8{\cdot}3 \times 10^4$
,,	1437.30	,, ,,	$5{\cdot}4 \times 10^{-24}$	$8{\cdot}3 \times 10^4$

The main event, beginning at 1624 U.T. on July 25, would appear to be closely associated with the intense solar flare which began at 1600 U.T. on that date and, according to Ellison[4,5], reached its peak brilliance at about 1627 U.T. The peak value in the solar energy of $1{\cdot}3 \times 10^6$ times black-body value lasted from 1624 until 1627.30 U.T. Surges of almost identical magnitude associated with solar flares were found by Appleton and Hey during the large sunspot of February 1946. These results (in publication, *Phil. Mag.*) have been communicated privately.

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Use of Lead Sulphide Photo-conductive Cells for High-speed Pyrometry

Lead sulphide photo-conductive cells were first manufactured during the War in Germany by Gudden, Kaspar, Kutzscher and others, though details have not yet been published. In late 1944 work on these cells was begun in Great Britain, and methods of manufacture were developed at the Admiralty Research Laboratory. This work will be described elsewhere. It is the purpose of this note to emphasize the value of these detectors for the measurement of rapidly varying surface temperatures, a problem which often arises in physical and engineering laboratories.

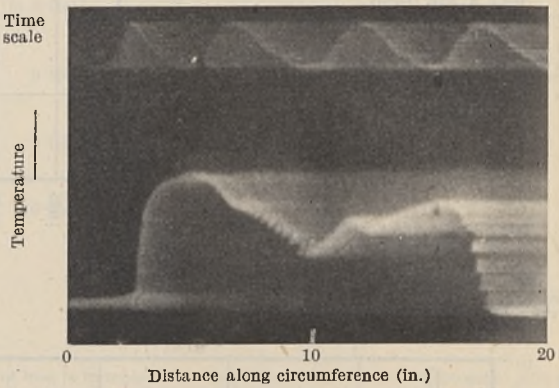
The cells are usually sensitive in the visible region of the spectrum, but the peak response lies in the infra-red region at 2·7 microns and the long-wave threshold is near 3·5 microns. An average cell of area 10 sq. mm., used at normal temperatures in conjunction with a radiation chopper and a tuned amplifier of response time 30 milliseconds, gives a signal equal to noise with 10^{-8} watts of radiation falling on it of wave-length between 1 and 3 microns. The response time can be decreased at the expense of sensitivity by increasing the amplifier band width. The response time of the cells themselves is of the order of 0·1 millisecond.

The radiation in the region 1–3 microns emitted by a black body at various temperatures is given below.

Temp. ° C.	100	200	400	600	800
Watts/cm.² emitted (1–3μ)	$1{\cdot}2 \times 10^{-4}$	$2{\cdot}4 \times 10^{-3}$	$7{\cdot}9 \times 10^{-2}$	$5{\cdot}5 \times 10^{-1}$	2·35

It will be seen that there is sufficient radiant energy available for pyrometric measurements of reasonable accuracy at temperatures as low as 100° C. Surfaces which are not black will, of course, give correspondingly reduced signals, and constancy of surface conditions is required for accurate temperature measurement.

Cells made at the Admiralty Research Laboratory have been applied successfully to problems of this kind. In particular, the determination of temperature changes taking place along the circumference of a 36-in. diameter railway wheel when subject to service braking from speeds up to 60 m.p.h. is being made at Messrs. Ferodo Limited, Chapel-en-le-Frith. Radiation from a 5 sq. mm. area of tyre falls on to the cell via an arrangement which comprises a water-cooled copper sighting-tube and a rotating slotted disk which serves as the radiation chopper. After amplification the signal is fed to one beam of a Cossor double beam C.R.O., while the other beam registers small angular deflexions of the wheel and a 50-cycle time trace. The amplifier employed, which was very kindly loaned by the Telecommunications Research Establishment, Malvern, has a response time of 1 millisecond. Deflexions of the beams are recorded by a moving film camera and so give variations of the temperature along the tyre circumference as the wheel decelerates. Calibration is effected by focusing the cell on a small cylinder of tyre material contained in a specially designed vacuum furnace, care being taken to match the optical paths and the surface condition of the metal.



A short length from a typical record is shown in the accompanying figure. The maximum temperature in this example corresponds to about 400° C., and it would appear that part or the whole of the tyre area viewed by the cell was in close contact with the brake for this limited period of the deceleration. In this equipment temperatures from 150° C. to 950° C. are covered in two ranges. The accuracy of measurement, which is determined by the width of the trace, is between 5° C. and 25° C., depending on the range of temperature covered. The nature of the variations of temperature over the surface will be discussed in a further publication.

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Absorption Spectrum of Trithioformaldehyde and Thiometaformaldehyde

The ultra-violet absorption spectrum of formaldehyde has been investigated by various workers and is now well known. In an attempt to investigate the corresponding spectrum of monomeric thioformaldehyde, the ultra-violet absorption of gaseous trithioformaldehyde and thiometaformaldehyde at temperatures up to 250° C. has been examined. Using silica tubes up to 50 cm. in length, no band spectrum was observed, absorption being continuous from 2739·5 A. to the lower range of observation, the intensity and extension of the absorption increasing gradually with the temperature.

The ultra-violet absorption spectra of saturated solutions of trithioformaldehyde and thiometaformaldehyde in chloroform, ethyl alcohol, sulphuric ether and carbon tetrachloride did not show any dependence on the nature of the solute, except for chloroform in which the absorption of the trimer started at a somewhat higher wave-length than the absorption in the meta solution.

A detailed account will be published later.

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Feeble Paramagnetism of Hexavalent Chromium

Feeble paramagnetism[1] is exhibited by certain ions in the ^1S state. As the spin quantum number in this case is zero, van Vleck[2] suggested that there remains only the contribution of the high-frequency elements of the orbital moment, as given by the second term in the formula:

$$X_{\mathrm{mol}} = -\frac{Nc^2}{6Mc^2}\Sigma\bar{r}^2 + \frac{2}{3}N\sum_{n' \neq n}\frac{|M^0(n';n)|^2}{h\nu(n';n)}.$$

The calculations of the two parts of the above formula, however, have been carried out only for the hydrogen molecule. The results indicate that the orbital paramagnetism in general has a very low value and may not form a basis for satisfactorily explaining feeble paramagnetic effect. An attempt has therefore been made to suggest another source for the paramagnetism shown by the ions in the ^2S state.

In compounds containing hexavalent chromium such as chromium trioxide and potassium chromate, the bond between chromium and oxygen is not fully ionic but partially covalent in nature[3]. The covalency consists of sharing of electrons between chromium and oxygen, and evidently, so far as the electronic effect in chromium is concerned, the spin may be considered as unpaired. The partial freedom of the spin due to imperfect pairing thus accounts for the fractional paramagnetic effect exhibited by Cr^{+6}.

Assuming that electronic charge distribution is spherical, structure diagrams were constructed on the basis of X-ray data[3,4] and ionic radii[5] for chromium trioxide and potassium chromate, and the total unpaired spin was calculated. The factor for the unpaired spin in both is 1/16. The values for the paramagnetism of the trioxide and potassium chromate calculated using this factor, after allowing for the diamagnetic effect, agree well with the values obtained experimentally by Grey and Drakers[1].

The details of this calculation will be published elsewhere.

Hexavalent chromium compounds were selected for this study as accurate X-ray[3,4] and magnetic data[1] for these compounds are available. Further work is in progress.

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Cleavage of Selenite and Mosaic Structure

In a former publication[1], an account was given of the examination of the topographical structure of a cleavage face of a selenite crystal, use being made of multiple-beam Fizeau fringes. Only low magnifications of area were used, yet it was observed that the fringes were extremely ragged, indicative of a complex surface 'fine-structure'.

We have extended these observations further, on selenite from a different source, using multiple-beam Fizeau fringes, and also fringes of equal chromatic order[2], both with up to × 400 linear magnifications, and with high and low dispersions. The earlier conclusions concerning the existence of the fine structure have been confirmed and extended. The surface structure is found to consist of a mass of short quite narrow strips, generally oriented more or less parallel to the major long cleavage lines (see ref. 1).

These narrow strips are not co-planar but vary slightly in height (depth) from 15 A. to perhaps some 800 A. on the particular samples examined. The strip width is usually of the order of a tenth of the length. Since some of the observed strip lengths are in the region $0{\cdot}5\text{–}1{\cdot}5 \times 10^{-3}$ cm., it seems probable that our microscope has failed to resolve many of the narrow strip *widths*.

We reproduce in Fig. 1 some high-magnification, high-dispersion fringes of equal chromatic order. Linear magnification on the original is × 400. Either fringe at λλ 6390 or 5480 respectively can be regarded as a contour of the crystal over the region selected by the spectrograph slit. The separation between orders represents 2730 A., and the various steps in a single fringe are encompassed within a height of 400 A. The vertical traverse across the picture represents 0·1 mm. along the crystal surface. Attention is directed to the high quality of the definition, the fringe width being quite a small fraction of the order separation.

As is clear, the particular section of the surface shown consists of a fairly regular series of alternating up and down steps, often of approximately the same height. The individual short features illustrated represent the strip *widths* and vary from 0·03 mm. to 0·005 mm. in this particular picture (the strip *lengths* are ten times as great).

Fig. 2 shows a traverse of another section with lower magnification (× 100) and about half the wave-length dispersion. A number of the fine-structure cleavage steps have been measured, and a sample of some of the smaller recorded steps can be grouped as follows.

	16	28	48	58	77
	14	29	43		73
	17	28			
	17	31			
	14				
Mean (A.)	15½	29	45	58	75

The lattice spacing for selenite cleavage given by X-ray measurements is 15 A. It is quite clear that these mean values are (within the experimental error) respectively 1, 2, 3, 4, 5 × (15 A.). Thus we have established the fact that the fine structure features are strips stepped frequently by only a few integral multiples of the unit molecular layer; at times, in fact, by but a *single* lattice layer.

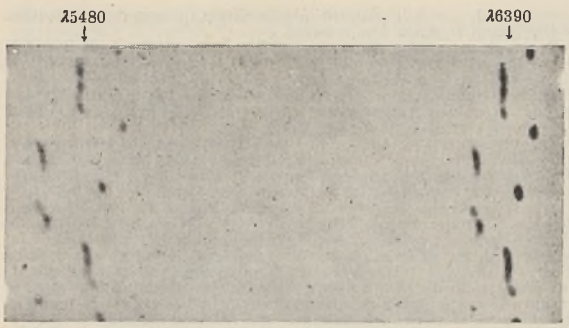

Fig. 1

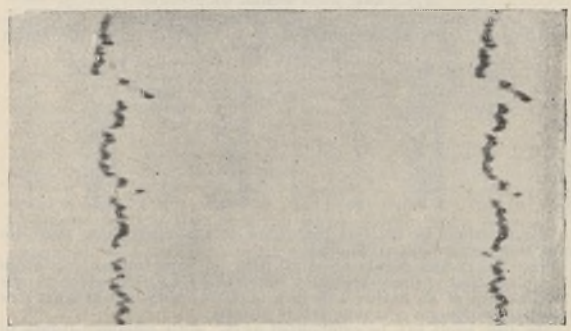

Fig. 2

These data seem to afford strong evidence for the existence of some form of mosaic or lineage structure in the selenite. If, as was postulated for mica and calcite[3], it can be supposed that cleavage is true to a molecular plane within a perfect crystal, then each simple elementary strip can be considered as a perfect crystal and cleavage is true to a molecular plane in such a unit, but jumping at the boundary to form a step. As to the size of such units, they vary considerably in area, from larger than 0·03 mm. × 0·3 mm. down to less than 0·005 mm. × 0·05 mm. It is not possible to give any indication of the true heights of the units, since clearly cleavage occurs at an arbitrary level and the cleavage steps need not necessarily be the heights of the blocks. Attention may be directed to the fact that, as in mica (despite the smaller lattice spacing), once again it is possible to evaluate an approximate crystal lattice spacing with visible light waves by virtue of multiple beam interferometry.

A more comprehensive report will be communicated elsewhere.

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Useful X-Ray Mutations in Plants

Ever since the discovery of the effect of ionizing radiations on genetic material it has often been questioned whether any mutations of value to the breeder could be produced by such means. This is because there is general agreement among geneticists that individuals with rare mutant genes are usually less balanced, and hence less fit, than the mean of the population. Nevertheless it suggests at least one useful application of X-rays—the artificial production of dwarf plants. Such dwarf plants may be useful in fruit trees for precocious root-stocks; and in cherries and pears where this need has not been met from the natural material, X-rays should be the ideal tool for making them. Another useful application is the production of self-compatible plants as explained below.

During the last nine years, many thousands of plants of *Oenothera organensis* have been examined and all have been found to be self-incompatible[1,2]. Furthermore this incompatibility is complete; after self- or cross-incompatible pollination no seed is produced even under the most rigorous conditions. Self-compatible plants have been produced, however, by pollinating from flowers which had received an X-ray dose of 500 r. units thirty-seven days previously. The X-rayed plant from which the pollen was obtained and the plant used as the female parent were sister seedlings, both having the constitution S_3S_4. From nineteen flowers pollinated one capsule developed and this contained thirty-six seeds. Thirty-four seeds germinated, giving plants of normal vigour. All were completely self-compatible. In their incompatibility reactions with their parents and with plants having other S genotypes these self-compatible plants were of two groups. *A* and *B*. The reactions based on pollen-tube growth and seed-set determinations of these two groups of plants are given in the accom-

panying table ; to help with the interpretation the genetic constitution of the *A* and *B* plants are included.

Two facts are evident from the first line of the table—both *A* and *B* plants are self-compatible and each plant segregates compatible and incompatible pollen in a 1 : 1 ratio. Hence a mutation has occurred giving self-compatibility only to the pollen carrying it, and since the original plant was S_3S_6 the new allele must have arisen from either S_3 or S_6 or a gene distinct from the S locus.

The second line of the table shows that plants in both groups, when used as male on to the original (unmutated) plant, again have compatible and incompatible pollen in a 1 : 1 ratio. It is not necessary, therefore, for compatibility to have the mutant allele in the style.

The reciprocal cross given in the third line of the table shows a striking difference between the two groups. When used as females, plants of group *A* are incompatible, while plants of group *B* are compatible with the original plant. Two conclusions can be drawn from this : (1) that group *A* plants are heterozygous and group *B* plants are homozygous for their S alleles ; (2) that the mutant allele does not produce the new 'self-compatibility' effect in the style but produces the same effect as the original allele did before mutation.

INCOMPATIBILITY REACTIONS OF MUTANT PLANTS WITH THEIR PARENT (S_3S_6) AND WITH OTHER GENOTYPES

S_6' is the mutant allele : ++, all pollen compatible ; +−, compatible and incompatible pollen in a 1 : 1 ratio : −−, all pollen incompatible.

	Group *A* S_3S_6'				Group *B* S_6S_6'		
	Selfed or intercrossed		+−		Selfed or intercrossed		+−
S_3S_6	×	S_3S_6'	+−	S_3S_6	×	S_6S_6'	+−
S_3S_6'	×	S_3S_6	−−	S_6S_6'	×	S_3S_6	+−
S_2S_6	×	S_3S_6'	++	S_3S_6	×	S_6S_6'	+−
S_2S_3	×	S_3S_6'	+−	S_3S_3	×	S_6S_6'	++
S_3S_6'	×	S_3S_6	+−	S_6S_6'	×	S_2S_6	+−
S_3S_6'	×	S_3S_3	+−	S_6S_6'	×	S_2S_3	++

The reactions in the last four lines of the table show that the mutation occurred in an S_6 allele.

Since thirty-four plants arose all with the same mutant S_6' allele it is clear that a single mutation occurred at an early stage in the development of an anther and in a nucleus which had at least five mitotic divisions to complete before meiosis.

The new allele can be symbolized as S_6', since although it fails to express its activity in the haploid pollen it has the full S_6 activity and specificity in the diploid style. This mutant allele is therefore a hypomorph to the normal allele, and since it has been produced by X-rays this is to be expected. But among spontaneous mutations which are known to occur at this locus some would be expected to be neomorphs, that is, new S alleles with a complete but new incompatibility reaction, since large numbers of different S alleles are present in natural populations.

That one and not both of the pleiotropic effects of the S gene has been affected by mutation raises problems of importance in gene structure and gene activity, and these will be discussed together with a full account of the work in a later publication.

It is now clear that self-compatible plants can be produced by X-rays in species which are normally self-incompatible. It is doubtful whether this will be an advantage in seed-reproducing crops where heterozygosity and hence vigour is maintained by cross-pollination. In such plants, under conditions unfavourable for cross-pollination, self-compatibility would have the short-term effect of increasing the immediate seed production, but the resulting loss in vigour from inbreeding during a number of generations would offset the initial advantage.

In fruit trees where heterozygosity is fixed by vegetative propagation the advantage of effective pollination under adverse conditions is not offset by loss of heterozygosity.

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Cytological Basis of High Fertility in Autotetraploid Buckwheat

AUTOTETRAPLOIDS of buckwheat obtained in 1941 by means of colchicine treatment showed variation with regard to fertility[1]. Owing to the vast amount of initial material it was possible to isolate in the variety Bolshevik individuals which were genotypically highly fertile. They differed in this respect from other experimentally produced autotetraploids the fertility of which was sharply reduced, some of them being even entirely sterile. Reduced fertility in autotetraploids depends primarily on irregular chromosome distribution in meiosis, leading to the formation of aneuploid micro- and macrospores and consequently to pollen abortion, poor seed setting and to the appearance of polysomics.

In the microsporogenesis of buckwheat autotetraploids during the first metaphase of meiosis only very rarely were exclusively quadrivalents observed ; in the majority of cases there were seven quadrivalents and two bivalents. At times the number of bivalents was considerably greater as a result of a decrease in the number of quadrivalents. Trivalents and univalents were observed only in plants with reduced fertility. The shape and orientation of quadrivalents on the spindle in autotetraploid buckwheat ensured regular chromosome separation. However, a small amount of irregular distribution was observed in all plants. The most common irregularity was the lagging of one or two chromosomes at the spindle equator, followed by the formation of dwarfed nuclei. Far less common was irregular chromosome distribution : 15 and 17 or 14 and 18. The proportion of abortive pollen varied between 2 and 6 per cent ; it was higher only in plants with reduced fertility.

In highly fertile plants there were observed extremely small abortive pollen grains containing one or two lagging chromosomes, all the large pollen being good. Consequently, pollen grains with aneuploid chromosome numbers $2n - 1$ or $2n - 2$ are viable. Hence the possibility of an appearance of polysomics. Indeed, polysomics have been discovered, although so far in the progeny of plants with reduced fertility only. They are distinguished by their reduced viability and, with rare exceptions, by complete or nearly complete sterility ; a great proportion of their seeds are incapable of germination. A hundred per cent germination of the seeds of highly fertile plants is evidence of the absence of polysomics in their progeny.

The main source of polysomics is in the progeny of triploids. Autotetraploids of buckwheat do practically not cross with diploids. Among 986 seeds collected in 1941 from chimeral plants there were found six triploid ones, three of which proved inviable ; the remainder were nearly completely sterile. Experiments on artificial pollination (658 crosses) furnished negative results. The rarity and, possibly, a complete absence of triploids, along with inviability of the majority of aneuploid combinations, make it improbable that a considerable number of polysomics may ever occur in the fields of autotetraploid buckwheat. The reduced fertility and nearly complete sterility of the latter would ensure a constant high fertility in autotetraploid buckwheat, and correct breeding work opens wide prospects of a further improvement.

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Homostyly of the Flowers of Buckwheat as a Morphological Manifestation of Sterility

BUCKWHEAT is a heterostylic plant, but as early as 1872, Müller described the occurrence in buckwheat, as in other heterostylic plants, of isolated homostylic flowers. In *Primula* and in flax, homostylic flowers were said to be morphologically aberrant but functional with increased self-fertility.

Our observations have shown that flowers of buckwheat appear to be homostylic in short-styled individuals when stamens are shortened, and in long-styled plants, when the pistil is reduced in size. The anthers of shortened stamens are reduced in size and filled with oval abortive pollen with a thin exine, or contain no pollen whatever.

The study of microsporogenesis showed that pollen degeneration was connected with precocious degeneration of the tapetum cells. The earlier degeneration of the tapetum begins the stronger is the reduction of stamens. The earliest degenerative phenomena were observed immediately after the completion of meiosis in pollen-mother cells ; the meiotic divisions themselves proceeded always normally. In these cells there occurs gradual dying of nuclei and of cytoplasm. Rudimentary stamens with completely empty rudimentary anthers are formed. When degenerative phenomena set in after the walls begin to be formed around the newly arisen pollen grains, there may be seen within the anther a cellulose plate consisting of adhering pollen-grain walls. When stronger walls have already been formed prior to the beginning of degeneration, a somewhat compressed empty pollen is formed. Such pollen is not shed from the anthers. Stamens are somewhat shortened in such cases so as to make short-styled flowers appear to be homostylic. It has since been found that such a sterility is more or less frequent in all the diploid varieties of buckwheat.

In many flowers reduction in pistils was also found, not only in the style but also in the ovary. This phenomenon was observed both in short-styled and in long-styled plants ; it is, however, easier to notice it in the latter. When the pistil is shortened to such an extent that the style lies at the level of the stamens or even below, the flowers give an impression of homostyly. It has been proved by experiments arranged in the summer of 1945 with diploids of the variety Bolshevik that these presumably homostylic flowers were never fertilized.

Microscopic examination of such pistils has revealed complete degeneration of the embryo sac, of the epithelial cell layer, and also of the cells of the integument. When only the style was shortened the embryo sac was developed normally and fertilization could take place. Indeed in such flowers where the stigma is somewhat raised above the level of stamens there was noticed after pollination a slight growth of the ovary, which ceased after a few days. Formation of normal seeds was never observed in these flowers. In the case of the presence of rudimentary stamens in short-styled flowers there were observed cases of the formation of normal seeds. There were cases of simultaneous reduction of both pistils and stamens.

It is clear that homostyly in buckwheat is actually due to sterility based upon genetic factors, while its manifestation may depend upon environment.

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The Coefficient of Variation

TEXT-BOOKS of statistics generally cite the coefficient of variation (or variability) as a measure of relative variability. While the coefficient (abbreviated to *CV*) is usually defined by the equation $CV = 100/AM$ (which is the form to which these notes refer), the more general definition is of a specified measure of dispersion expressed as a percentage of some appropriate measure of central location. Simpson

and Rowe[1] give a list of seven formulæ which by no means exhausts the logical possibilities.

In view of certain erroneous statements which have been made as to the nature and meaning of this coefficient, and of certain fallacious inferences drawn from its use, it is thought desirable to offer the following comments, based upon a preliminary examination of the problem from the biological point of view, in the hope that workers with the necessary statistical and mathematical equipment might be persuaded to give some attention to the development of this device which, it is thought, could be of considerable value in taxonomic practice.

The following points in connexion with this coefficient seem to have been overlooked :

(1) It is an index expressing one mean value (root mean square deviation) as a percentage of another mean value. Accordingly, the values normally calculated may be regarded as being possibly not true values since no correction is ever made for correlation effects, and notably no correction is made for the effect of spurious correlation which arises where an index is calculated from mean values, as shown by Pearson[2] ; nor is correction ever made for the correlation which generally exists between a mean and its standard deviation.

(2) The numerator of the index is a quantity determined by many factors according to which it can be partitioned. The *CV* is customarily calculated only from such values of the standard deviation as may be to hand : at best these are sample values and it cannot be held that they accurately represent the variability of the particular group to which they refer. Accordingly, it is likely to be erroneous to compare the *CV*'s of two groups, unless the conditions of sampling, that is to say, the sources of variance, are identical. Even when sampling conditions are similar, such comparison of *CV*'s can be regarded as evidence of relative variability of the groups only in respect of the particular measurements to which they refer. Comparison on other measurements may reverse the relative positions.

(3) The correlation between a mean (of a particular measurement) and its variance is extremely variable and is itself a feature to be determined. Accordingly, values of the *CV* cannot usually be predicted on biometrical grounds alone. Thus, for the one measurement in a particular species the *CV* may or may not vary with sex, age, locality, season or other factor. Again, the coefficients of different measurements in the one species may or may not be the same and may or may not behave similarly in respect of such factors as sex, age and so on. Similar observations may be made in respect of the *CV* of a particular measurement made on different species, or genera. I have compiled tables of means, standard deviations and *CV*'s, and find it generally demonstrable that the characteristic value of the *CV* for any measurement in any group cannot be predicted, but must be separately determined. This does not deny that the behaviour of this coefficient might be according to some discernible law, particularly if some alteration were made in the manner of its calculation. However, this is a question of the relationship between two variables (the mean and the variance) under various conditions, and such relationship cannot be analysed by means of an index. Finally, as a matter of immediate practical importance, it is fallacious to attempt to set any *general* limits to the value of the *CV* or to draw any particular conclusions from departures from such limits.

(4) Since so many factors may contribute to the size of the variance, and since the manner of that contribution cannot be predicted, it is impossible to argue *to the sample* from the value of the *CV*. But departures in subsequent samples, from the value of the *CV* established for a particular specification of sampling, might serve to indicate that the conditions of sampling had been departed from, or that certain changes in the population had occurred.

However, despite these limitations to the *CV* it is desirable to have some measure of relative variability, and it is thought that with some modification, and with care in the specification of the conditions of use, the *CV* can serve this purpose. In the first place a *CV* should be cited, as a taxonomic feature, only where the material from which it was obtained can be precisely specified. Secondly, since the object is to permit comparisons, it would be desirable to effect some choice of conditions of sampling which can be generally reproduced ; thus it might be wise to specify the *CV* for the sexes separately, to specify a single locality (say, the type locality) and only a few age groups. Thirdly, it would be a useful innovation to cite the *CV* partitioned according to the various sources of variance ; coefficients could be quoted for each of the most important sources of variance and one for the residual variance. The latter might prove to be a fundamental characteristic of the species. The need for coefficients for 'interaction' would depend upon the magnitude of the effect. Finally, further refinements could be introduced by the adjustments possible through the covariance analysis. However, the *CV* should be an end-product of a detailed analysis : crude values should not anticipate such analysis.

While the *CV* in its present form is of very limited value it probably could be made a most useful adjunct to the usual set of statistical measures quoted in taxonomic works.

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[1] Simpson and Rowe, "Quantitative Zoology" (McGraw-Hill, 1937).
[2] Pearson, K., *Proc. Mag. Soc.*, **60**, 489 (1897).

A General Class of Confidence Interval

Among types of statistical inference about unknown parameters statements are possible which have a statistical truth, that is, they are random variables such that within the statistical framework adopted the probability of their being in error is known. In these statements intervals, called by Neyman confidence intervals, are assigned to the value of an unknown parameter. On generalization to more than one unknown parameter these intervals become multi-dimensional regions ; but I have pointed out[1] that the existence of such regions does not of itself imply in Neyman's theory the corresponding existence of regions of lower order, equivalent to the elimination of irrelevant unknown parameters.

However, the logical statement concerning the simultaneous boundary of several parameters *includes* a statement about the *maximum* boundary of any selected set of these parameters, and consequently if the total statement is true with probability $1 - \varepsilon$, the included statement is true with probability not less than $1 - \varepsilon$. When the selected set consists of only one parameter, this fact gives rise to a general class of confidence interval for one parameter that includes all previously known 'exact solutions' with probability $1 - \varepsilon$ and also new solutions with probability not less than $1 - \varepsilon$. When optimum exact solutions do not exist, investigation of the optimum solution of the new type may still be possible.

In Fisher's most recent discussion[2] of his theory of fiducial probability, including the problem of testing the difference between two means, for which the Behrens–Fisher test does not constitute a solution *in the above sense*, he seems to throw out a challenge to critics of this test to provide an alternative 'tolerable solution'. In my original critical discussion[3] the existence was noted of a two-parameter fiducial distribution for the true difference between the two means and the true ratio of variances. In addition to solutions of the confidence interval type previously noted, this two-parameter distribution implies a possible solution of the new type suggested above, for which the optimum (that is, shortest) confidence interval may be calculated. This particular solution, since it is based on an inequality, is not obviously more powerful than others based on exact solutions of a non-optimum type, but its statistical properties are open to investigation. But 'validity' and 'tolerability' should not be confused—the solution proposed here is valid in the sense defined, whether or not on more detailed examination it proves 'tolerable'.

Note added September 23. Since this letter was written, Dr. B. L. Welch has shown me the manuscript of a forthcoming paper in *Biometrika*, in which he puts forward a new solution of the confidence interval type for the 'difference between two means' problem. His solution appears to be exact, at least in the sense of allowing a series expansion for the true limits in terms of the initial large-sample normal approximation, and promises, much more than my own suggestion, to provide the so far missing 'tolerable' solution. I have also been interested to learn from recent conversation with Prof. A. Wald of some related unpublished work of his on the existence of such an exact solution.

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Aug. 21.

[1] *Ann. Math. Stat.*, **10**, 129 (1939).
[2] *Sankhya*, **7**, 129 (1945).
[3] *Proc. Camb. Phil. Soc.*, **32**, 560 (1936).

Random Associations on a Lattice

Given a lattice of $m \times n$ points, suppose that each may be 'black' or 'white' with probabilities p and $q = 1 - p$. The probability distribution of the number of 'black-white' joins is then of interest in several branches of science[1,2,3]. The expected number is $2pq(2mn - m - n)$ and the second moment about the mean is $2pq\ (8mn - 7m - 7n + 4) + 4p^2q^2\ (13m + 13n - 14mn - 8)$.

As m and n increase, the distribution tends to normality, and this may be proved by methods similar to those used by Bernstein[4] in his work on Markov chains. Similar results can be obtained for the number of 'black-black' joins and also the corresponding results in three dimensions. Levene[5] has announced results dealing with a different but similar problem. A full account will appear later.

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[1] Mood, A. M., *Ann. Math. Stat.*, **11**, 367 (1940).
[2] Ising, E., *Z. Phys.*, **31**, 253 (1925).
[3] Wishart, J., and Hirschfeld, H. O., *J. Lond. Math. Soc.*, **11**, 227 (1937).
[4] Bernstein, S., *Math. Ann.*, **97**, 1 (1926).
[5] Levene, H., *Bull. Amer. Math. Soc.*, **52**, 621 (1946).

Experiment and Theory in Statistics

Mr. D. V. Lindley[1] distinguishes between the curve of best fit and the regression curve on the ground that the former gives the best estimate of the relation between the true values of the variables, while the latter gives the best estimate of the true value of one variable from the observed value of the other. He thus provides a convenient opportunity to raise a question that I have long wanted to raise, namely, whether there is any experimental evidence for this and similar deductions from statistical theory.

Direct experimental tests are not easily devised ; for the meaning of the conceptions involved in such statements is derived largely from the theory on which they are based. But the first statement seems capable of test. The true values must surely be independent of the method of examining them. Accordingly, if many different sets of observations are made on a system by many different ways, the curves of best fit from the different sets, rightly calculated, should agree significantly better than curves calculated in any other way, for example, better than the regression curves. Is this true ?

Nor are the tests easy to apply. A single worker seldom accumulates enough observational material to apply the test : he cannot use the observations of others, because sufficient details are scarcely ever published. The application of the tests requires organised co-operation. Until it is undertaken and the tests proved to be successful, all use of elaborate statistical theory is precarious.

Norman R. Campbell

Sept. 2.

[1] *Nature*, **158**, 273 (1946).

DEVELOPMENT OF MILK RECORDING IN GREAT BRITAIN

IT has become clear in recent years that the general performance of British dairy stock in terms of milk yield and breeding efficiency is sufficiently low to constitute a major handicap to any advance, although the existence of some high-producing cows and high-yielding herds shows what might be accomplished by improved breeding and husbandry.

The obvious technique for assessing levels of performance is milk and butter-fat recording. But to attain real value, recording must be applied to a sufficiently large sample of the cow population to give a representative picture of the industry, and its results must be not only comprehensible to cattle breeders but also legitimately usable in any improvement programme. These considerations formed the background to the discussions on the collection, interpretation, and use of milk performance records by the British Society of Animal Production at its Glasgow meeting held on August 7.

The milk recording movement in Great Britain is not a new one. Measures of co-ordination have existed for some time; for example, the Scottish Milk Records Association was formed in 1914. However, an almost negligible amount of scientific study has been given to it, its main uses being to furnish records for the information and propaganda of the individual breeder and for breed societies to incorporate in some form of register of superior animals. The movement as such attained a greater measure of co-ordination in 1943, when the Milk Marketing Board assumed responsibility for recording in England and Wales, but differences in the technique of recording and presentation of records still occur between the English and the Scottish systems. In 1943 about 5 per cent of the cow population of England and Wales were recorded; by 1946 the recorded sample of 17,000 herds included about 17 per cent of the cow population. Mr. Joseph Edwards estimates that, under the present system, a total of twenty to twenty-five thousand herds would give a sample of 20 per cent of the cows. This would be sufficient for the investigational purposes now envisaged by the Board, relating to the yields of milk and butter-fat by breeds, as between pedigreed and non-pedigreed stocks, and according to age and other environmental conditions, such as season of calving and frequency and methods of milking, as well as to keep track of the results of artificial insemination as a means of livestock improvement. Mr. Edwards' description of the methods to be used by the Bureau of Records of the Board in collecting, tabulating and presenting the data was fully appreciated, especially by those members of the Society who recognize that, as Dr. H. P. Donald expressed it, "one of the proper studies of recording is recording itself".

The stage is now being set for the beginning of a new era of development in milk recording, so far as Great Britain is concerned. There has been much confusion of thought as to the uses and limitations of recording systems and the records which emerge from them. The problems fall into two broad groups: (*a*) those of the techniques and systems themselves: their accuracy; the analysis of results in order to give data which can be utilized for comparative evaluations of performance; the standards and training of the personnel; the degree of intimate co-operation with the farmers that can be brought about; (*b*) those of the purposes of the records: to guide breeding policies; to enhance production by non-genetic means, such as improved feeding and husbandry; to be combined with health surveys to assess the incidence and relative significance of the various sources of loss, wastage, and inefficiency which affect the industry, and so to provide a factual background for specific investigations.

Extension of recording in combination with field survey work on such lines is being actively pursued in New Zealand, and Mr. Arthur Ward's account of recent developments there gave a definite picture of a satisfactory working mechanism, some of the attributes of which might well be imitated in Great Britain. Because of the benefit accruing from proper collection of data to the New Zealand dairy industry as a whole and to the research institutions, the Government and the industry contribute to the funds of the movement, while representatives of the industry and of the Government form a technical committee which decides the data to be collected and the problems to be investigated. But the crucial steps in the conduct of the work are those which ensure that the farmers are kept fully informed of the reasons for the particular investigations, as well as of the results which emerge from them.

In connexion with the new developments in Great Britain, it is important to recognize that the interpretation and application of the performance data in such an industry must be carried out on more than one plane. The individual herd is a relatively small unit; the breed amounts to a more or less discrete, much larger group. The individual breeders have their own domestic herd problems; people concerned with the larger groups are dealing with cattle aggregates, that is, with populations. (The growing use of artificial insemination introduces an intermediate set of problems.) The requirements and purposes of the two interests are not always easily reconciled, and differences in point of view may be magnified when the whole cattle population of a country is involved.

The individual herd owner knows the history of his herd, of changes in management, and of disease effects. This knowledge, if intelligently used, can give a good background to a practical assessment of performance records. But these records must be reasonably presented, and in such a form that the owner of the herd can trace the performance also of the bulls in use, as, for example, by dam-daughter comparisons. For this purpose the graphical presentation of raw records is straightforward and practical. 'Corrected' records applied to individual cows can be misleading or misread, and are certainly disliked.

On the other hand, those who are concerned with the broader aspects—the population basis—require the data in forms which allow adequate comparison; for this, some series of correction factors are necessary. Though corrections for regional differences would be seriously unpopular in many quarters, the fact that they can be derived, as, for example, in the work of Prof. Bonsma in South Africa, or for Swiss alpine conditions, points to possibilities even in Britain. Meanwhile, it is a sad reflexion that in their new advanced registry scheme, the Ayrshire Cattle Society has perforce to use correction factors derived in America for American conditions, and that Sanders' factors, developed some twenty years ago for a limited material in England, are of doubtful validity for other British recording data. The mass of records

which will now be automatically collected and tabulated under the Milk Marketing Board scheme will give badly needed material for bringing our knowledge of the dairying industry in Britain at least into line with that of other countries. Mr. Edwards' assurance that this material will be available to breeders and to research workers is particularly welcome, and goes far to ensure wide confidence in the scheme and in the data.

For confidence in such data—in all stages of their collection, tabulation and treatment—is vitally important. That there must be some arbitrary decisions, or compromises, in the records themselves is always admitted (a standard lactation of 305 days is one such compromise); so also is the fallibility of an official record as representing the true performance in any one lactation of any one cow. But the validity of the records is of interest to more than the individual herd owner; within breeds, between breeds, within and between localities and farming systems, within and between countries, breeders, administrators and research workers must have equal confidence in the validity of the records before proper, intelligent and progressive use can be made of them. To this end, the fundamental needs are for well-trained personnel throughout the recording system, for high standards of accuracy within practical limits, for a wide adoption of general principles and methods, and for close collaboration between breeder, recorder and investigator.

The records when collected must be usable and used; continuous, independent, scientific study and advice must be freely available and accepted, so that the recording movement may function soundly and progress to greater service to the milk-producing industry.

J. E. Nichols

MANTLE CHAMBERS OF *TRIDACNA ELONGATA*

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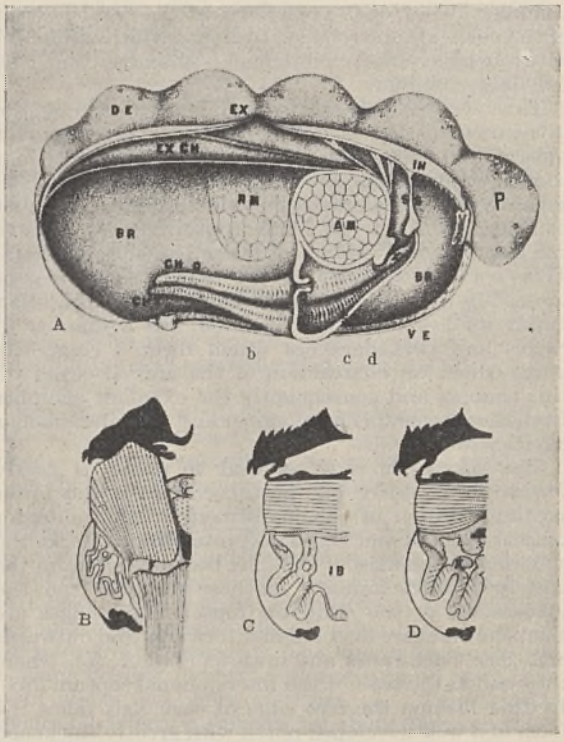
In a preliminary communication[1] it was pointed out that members of the Tridacnidæ are of a comparatively high efficiency in taking in ordinary net-zooplankton. This efficiency was attributed to the possession of members of this family of a well-developed sucking, sieving and pumping mechanism which is constituted by the different chambers of the mantle.

Both Vaillant[2] and Lacaze-Duthiers[3] devoted some attention to the morphology of the mantle chambers of *Tridacna elongata*, but neither of them realized the significance of the form and the arrangement of these chambers.

Fig. *A* represents a dissection of the right half of *Tridacna elongata* displaying the mantle cavities and how they are related to one another. From the inhalant opening (*IN*) water passes into the branchial chamber (*BR*), in which the gills hang freely. This cavity is at its narrowest in the region of the muscles (*AD* and *RM*). On percolation through the gills, the water passes into the interlamellar chambers (*CH* 0 and *CH* 1) of the outer and inner demibranchs respectively.

Just behind the foot and below the adductor muscle, the inner lamellæ of the inner demibranchs



Mantle chambers of *Tridacna*

A, right half of the animal with the different chambers exposed; *B*, *C*, *D*, transverse sections across *b*, *c*, *d* of *A*.

fuse with one another, forming a well-developed septum (*S*) which is referred to as the interbranchial septum. This septum defines a chamber—the interbranchial chamber (Figs. *B*, *C*), which is bound dorsally by the investment of the ventral surface of the adductor muscle, laterally by the axes of the gills and ventrally by the interbranchial septum itself. This chamber is at its deepest anteriorly, where the interbranchial septum is almost vertical in position and is as high as the foot. This vertical anterior wall of the chamber is very remarkable in having a central well-defined opening, which puts this chamber in direct communication with the branchial chamber. This opening was referred to by Vaillant[2], who concluded, from its form and the orientation of its lips, that it can only lead the water directly inwards from the branchial chamber. Fuller description of this opening and the part it plays in the life of the animal will be referred to elsewhere. At present it suffices to mention that this peculiar opening is established at an advanced stage in the life of the animal, since in specimens up to 5 cm. in length there is no trace of it, while specimens of 10 cm. all showed it in a very distinct fashion.

Anteriorly, the interbranchial chamber communicates on each side with the interlamellar cavity of the corresponding inner demibranch and laterally it receives the water percolating through the remaining part of the same demibranch. Posteriorly, this chamber narrows to a tube, which curves vertically upwards and puts this interbranchial chamber in communication with the exhalant chamber (*EX*, *CH*), which lies dorsally between the forwardly extended mantle edges (*DE*).

The interlamellar cavities of the outer demibranchs (*CH* 0) are quite independent of the interbranchial

chamber. They open posteriorly at the basal portion of the vertical tube referred to above, which communicates between the epibranchial chamber and the exhalant chamber.

This vertical passage is bound anteriorly by the investment of the posterior surface of the adductor muscle and posteriorly by a septum (*SS*), which is continuous with the interbranchial septum and which separates the inhalant part of the branchial chamber from the exhalant one. This septum corresponds to the intersiphonal septum of other Lamellibranchiata. This vertical channel in its upper region passes insensibly into the exhalant chamber. On the other hand, its lower or basal portion has a number of ridges and protuberances which form a composite plug, which on contraction of the animal closes off this channel and consequently the exhalant chamber from the interbranchial chamber and the interlamellar cavities of the gills.

The composite plug referred to above is partly formed of a fairly big protuberance on the lower posterior region of the investment of the adductor muscle (Figs. *A* and *D*). This protuberance marks the spot where the axes of the gills become free from the body wall of the animal. As these get loose from the investment of the adductor muscle their edges are thickened and are directed first forwards and outwards and then backwards and inwards (Fig. *A*, *X*), where they end at the base of the intersiphonal septum (*SS*). In this fashion the free edge of each axis takes the form of a well-developed notch with greatly thickened lips which mark the opening communicating the interbranchial cavity with the vertical tube and consequently the exhalant chamber. At the base of the siphonal septum (*SS*) there is a thickened part which corresponds to the protuberance facing it on the investment of the adductor muscle.

When the animal contracts, the posterior region of the thickened mantle edge, which is very highly muscular (*A*, *P*), coils downwards and forwards and comes to press on the siphonal septum, which in its turn presses on the posterior surface of the adductor muscle. In this fashion the thickened region of the septum, together with the protuberance of the investment of the adductor muscle, are applied close to one another, blocking the major part of the cavity of the tube. At the same time, the thickened edges of the free part of the axes are also applied together, blocking the side parts of this communicating tube.

The exhalant chamber, which is continuous posteriorly with the vertical tube, is in the form of a well-defined bag extending on the dorsal surface of the animal. It ends blindly at the extreme anterior end of the animal (*A*). It opens to the outside by the well-defined exhalant opening (*EX*), and its only communication with the other chambers of the mantle is through the communicating vertical channel (cf. text Fig. 3 of Yonge[4]).

The exhalant chamber is provided with a number of well-defined muscle bands (oblique and vertical), running between the floor of the chamber in the region of the adductor muscle and the roof of the chamber in front and behind the exhalant opening. The part these muscles play in the process of pumping out the water from this chamber to the outside is very obvious. The retractor muscles of the foot also seem to have a very important part in this process. A great number of their elements run between the foot (*F*) and the thickened mantle edge in the region of the exhalant opening (*B*).

The combined action of the muscles of the thickened mantle edge especially at the posterior end, of the adductor muscle, of the vertical and oblique muscles of the exhalant chamber and partly that of the retractor muscles, brings great pressure upon the contents of the exhalant chamber, and hence the remarkable spouting of the water through the exhalant opening. The insertion of the retractor muscle into the mantle edge in the region of the exhalant chamber seems also to provide support to the roof of the chamber round the opening and prevents rupture through the great pressure from the inside when contraction takes place. In the contracted condition the composite plug referred to above seems to be quite efficient in stopping any communication between the exhalant chamber and the interbranchial and the interlamellar portions of the mantle cavity. The difference of pressure in these two sets of chambers when the animal is contracting must be very great, and the importance of the plug in such a condition is quite obvious.

When the animal retracts, the capacity of the exhalant chamber increases greatly, the vertical tube increases in width, and water coming originally from the branchial chamber is sucked upwards into the exhalant chamber from the interbranchial chamber and the interlamellar cavities of the gills.

The alternate contraction and retraction of the muscles of the animal in the way described above causes, at least at intervals, a strong current of water to pass through the gills. The food-collecting value of this process cannot be overlooked. Experimental data pertaining to the pressure in the different chambers and the rate of flow of the water through the animal are forthcoming.

[1] Mansour, K., *Proc. Egyptian Acad. Sci.*, **1** (1946) (in the press).
[2] Vaillant, L., *Ann. Sci. nat. Zool.*, (5), **4** (1865).
[3] Lacaze-Duthiers, H. de, *Arch. Zool. Exp. Gén.*, (3), **10** (1902).
[4] Yonge, C. M., Great Barrier Reef Expedition Sci. Rep., 1, No. 11 (1936).

PERIODIC PARTIAL FAILURES OF AMERICAN COTTONS IN THE PUNJAB

A COMPREHENSIVE account of this malady, together with the remedial measures to be adopted, has been given by Prof. R. H. Dastur ("The Periodic Partial Failures of American Cottons in the Punjab : Their Causes and Remedies". Sci. Monograph No. 2, India Central Cotton Committee, Bombay, 1945). The failure in question is of the nature of a physiological disease, popularly known as 'tirak', the symptoms of which include the premature cracking of bolls with immature seeds and poor quality of lint. On light sandy loams the leaves become discoloured at the onset of the reproductive phase, the characteristic yellow and red colours being followed by premature leaf fall. A study of the cotton crop in the Punjab in all its phases of growth led to the general view that where tirak is evident the vegetative and reproductive phases are physiologically unbalanced : the detailed investigation of this hypothesis has been productive of many interesting results of both practical and scientific interest.

In the first place, tirak is now regarded as a comprehensive term for several abnormal physiological developments induced in American cottons (*Gossypium hirsutum*) under quite different soil conditions.

Two particular soil types are specified as being liable under certain conditions to give rise to tirak: these are light sandy loams deficient in nitrogen, and soils which contain free sodium salts or sodium clay in the subsoil. Different types of physiological disorder are induced under the two sets of conditions, but the name tirak is still retained to cover both. The more evident symptoms which develop on the first soil type have already been indicated; but in addition it has been found that in the leaves of affected plants there is an abnormal accumulation of starch in the cells of the mesophyll. This starch is not removed during the night, as in normal leaves, but continues to accumulate until in extreme cases the chloroplasts become ruptured. An abnormal accumulation of a tannin-like substance is also present in the cells, its presence being antecedent to the development of the external symptoms of tirak. The relation of these abnormal developments to nitrogen deficiency has been established by appropriate experimentation. The observation that, on light sandy loams, tirak cannot be attributed to nitrogen deficiency alone led to investigations of the water economy of the plant. Water deficiency during the reproductive phase was also found to be a factor in the situation. Thus where water deficiency is important, as in soils with subsoil salinity, affected plants show a pronounced drooping of the leaves; these leaves also become dark-coloured and dull, they lose their fresh green shining appearance and are prematurely shed. In this type of tirak the yellowing seen in nitrogen-deficient plants is not present; there is likewise no evidence of the accumulation of starch or tannin, but certain protoplasmic abnormalities are evident. Both types of tirak-affected plants are characterized by a low potassium content in leaves and carpels, depressed synthesis of proteins, and decreased oil formation in seeds.

A careful consideration of all the relevant biochemical data has led to the conclusion that the low potassium content is the starting-point of the internal disorders in tirak plants. The disorders associated with this deficiency develop in different ways in plants growing on the two soil types: in the light sandy loams the uptake of potassium is low because of the shortage of nitrogen; on saline soils physiological drought interferes with the normal uptake of minerals. Thus Prof. Dastur concludes (p. 71): "The common symptom, *viz.*, immaturity of seed, therefore, developed in plants on both soil types though the symptoms exhibited by the leaves of *tirak*-affected plants on the two soil types were found to differ". Such a finding gives some idea of the difficulties inherent in the investigation of a crop failure which is due to physiological disorders.

Broadly speaking, the field aspect of the problem has been diagnosed along the following lines. When Punjab-American cottons are sown early in May, the combination of light soil, long days and regular water supply makes for strong vegetative growth. Flowering begins about the last week in August. It is a curious and important fact that any change in the date of sowing is not accompanied by a similar shift in the onset of flowering; that is, all sowings tend to come into bearing within a rather narrow period. Moreover, flowering tends to occur in a flush and thus imposes a heavy demand on the supplies of nitrogen and other minerals. This is particularly so in the case of the strongly vegetative plants which result from the early May sowings. In point of fact, a large number of flowers do not come into fruition as fully developed bolls. This tends to be accentuated in soils which are deficient in nitrogen or which suffer from physiological drought, with the concomitant development of the two types of failure described as tirak. These and many other interesting aspects of the problem are fully described and discussed.

A substantial part of the report deals with the remedial measures to be adapted to different soil types. To quote from the report (p. 137): "The application of nitrogen to light sandy soils prevented the development of *tirak* symptoms caused by nitrogen starvation and the application of extra water at the fruiting stage prevented the development of physiological drought on soils with saline subsoils. Both these remedies proved specific for the two soil types and naturally they must be applied at the right place.

"The importance of the June-sowings as a preventive measure against *tirak* was its general applicability. It was found efficacious on all soil types as it put the crop in equilibrium with its surroundings. . . . The plants were able to carry on their normal functions with less nitrogen and less water [than the May-sowings] and the deficiency of these substances did not develop. The plants were also better able to stand the adverse weather conditions at the fruiting stage and thus general intensification and spread of *tirak* were greatly lessened. The internal economy of the plant greatly improved and the plant produced less of sticks and more of fruits. . . . This simple measure of deferring sowings by about three to four weeks has been found to result in great profits to cotton growers and many of them have already benefited."

Prof. Dastur and his collaborators, and the Indian Central Cotton Committee which sponsored and financed the work, are to be congratulated on the successful outcome of this long and intricate investigation.

TRANSMISSION OF FINGER-PRINTS BY RADIO

THE transmission of pictures and of written or printed material over line and radio telegraphic circuits is an achievement of long standing; but in recent years enormous advances have been made in the technique of radio transmission and reception in this field, resulting in very marked improvement in the quality and detail of the reproduced pictures, excellent examples of which are frequently to be seen in the daily Press. The successful transmission to a distance of reproductions of human finger-prints obviously demands an unusually high quality in this technique, and a study of the problems involved in this application has been the object of tests conducted during the past year between Great Britain and Australia.

These tests are described in an interesting pamphlet entitled "Radio Transmission of Finger Prints", by Superintendent F. R. Cherrill, officer-in-charge of the Finger Print Branch, New Scotland Yard*. A foreword to this document refers to an article entitled "The Description and Use of the Pores in the Skin of the Hands and Feet", published in the *Philosophical Transactions of the Royal Society* in 1684 by Dr. Nehemiah Grew, who was at one time secretary

* Radio Transmission of Finger Prints. By Supt. F. R. Cherrill. Pp. 12. (Commissioner of Police of the Metropolis, New Scotland Yard, London, S.W.1, 1946.)

of the Society. A drawing of a hand emphasizing the features of finger- and palm-print patterns is reproduced from this article. The memorandum is, however, essentially concerned with the results of successful tests in the long-distance identification of criminals conducted during the past year by New Scotland Yard in co-operation with the Commissioner of Police, Victoria, Australia, and Messrs. Cable and Wireless, Ltd.

The report is illustrated by a specimen transmission card which contains, in addition to two photographs of the wanted person, an enlarged print of one finger with coded description of the other nine digits, and a complete description of the individual, and the information required in connexion with him. All this matter is contained on a card approximately 10 in. × 9 in. in size; and this formed the picture which in one test was transmitted from London to Melbourne in seven minutes so successfully that a cable setting forth the person's record was received from Melbourne the next morning. These tests thus culminated in the successful identification in Australia of a person who was actually in custody in Great Britain and whose trial was imminent. Similar facilities for radio picture transmission are now available between London and many towns in various parts of the world, both within and outside the British Empire.

BIRDS OF PALESTINE

WHILE serving in Palestine, Captain Eric Hardy became the secretary of the Jerusalem Naturalists Club which had been founded for the troops by Middle East Command to stimulate interest in and co-ordinate the numerous inquiries in natural history that were already being pursued by a number of individual soldiers. One of the most notable activities of the Club was the listing of the birds of Palestine. The duty was undertaken because of the lack of a modern and authoritative account of Palestinian birds, and, besides their records of 364 species and 68 sub-species, work was also carried out on problems of migration. These, together with records of the most-used bird haunts, have been put together by Captain Hardy in a privately printed list which, it is hoped, will be the forerunner of an authoritative and comprehensive handbook of Palestinian ornithology*.

The region is of particular interest because the Palæarctic region of the north and the Ethiopian region of the south meet across the centre of the country. The little owl, for example, shows interesting northern, southern and intermediate races, and several African birds like the sunbird (*Cinuyris*), the darter (*Anhinga*), the sooty falcon and the lappet-faced vulture (*Otogyps*) penetrate the country from the Syro-African Rift Valley, and oriental birds like the fishing owl (*Ketupa*) and the black-headed bunting (*Emberiza melanocephala*) also occur. The main migration routes between Europe and Africa pass through the country.

The only native bird to migrate to Palestine is the gannet (*Sula bassana*), although several 'British' species from eastern Europe, like the European swallow, the rook, redshank, teal and cuckoo, are seen. There are also several closely allied races of the birds known in Britain, like the chaffinch, great tit, kingfisher, robin, song thrush and blackbird. The blackbird, skylark and song thrush do not sing in Palestine in their winter sojourn, and the robin sings only occasionally at daybreak. The cuckoo rarely calls on its migration; nightjars do not sing. Absence of bird song, particularly thrush song, is noticeable to the British visitor, but the song-birds common to Britain and Palestine are the greenfinch, great tit, chaffinch, goldfinch, corn-bunting and, occasionally, the chiff-chaff. The familiar calls of the robin and redshank are commonly heard in winter, but the robin, as well as the blackbird and song thrush, are much shier and less easy to approach than in Britain. Birds peculiar to Palestine include the Palestine babbler, the Palestine blackstart, the Palestine graceful warbler, Tristram's grackle and the Palestine sunbird. The grackle and the sunbird are extending their way northwards from the Dead Sea depression. The bulbul is supposed to have increased its numbers considerably this century, but several birds have decreased. The white stork, the lammergeir, the imperial eagle and the white-faced duck no longer nest in the country, while the great bustard, the Syrian ostrich and the Egyptian goose are apparently extinct in Palestine. Unlike Cairo, Jerusalem and the cities of Palestine are not the habitat of flocks of kites, but also unlike Cairo, Jerusalem, Haifa and Tel Aviv have a large summer nesting population of swifts.

* A Handbook of the Birds of Palestine. By Captain Eric Hardy. Pp. iii+50. (Education Officer-in-Chief, G.H.Q., Middle East Forces, 1946.)

CARNEGIE INSTITUTION OF WASHINGTON

REPORT FOR 1944-45

ONE of the most interesting passages in the report of the president of the Carnegie Institution of Washington, Dr. Vannevar Bush, which is included, together with the reports of the executive committee, the auditors, and on departmental activities, in the Yearbook No. 44 for 1944–45, covering the year July 1, 1944–June 30, 1945, is that in which he discusses the future of scientific research, and particularly the bearing on it of the Selective Service, the further extension of which as regards science and engineering students has since been severely criticized by H. A. Meyerhoff (*Science*, April 19). Dr. Bush points out first that while the United States is at last awake to the value of scientific research, it is not by any means certain that every area where the scientific method can add to man's understanding of himself and his environment will be adequately explored, and that the danger of lack of balance between applied research, research in the physical sciences, medical science and in other fields may be exaggerated by the serious deficit in scientific man-power due to the policies pursued during the War. The two governing principles, that every citizen should be ready to sacrifice equally in the common cause and that every man should be used in the place where his talents can contribute most fully to the common effort, were not in balance. As a result, by taking too many trained young scientific workers and engineers out of the laboratories and industry, part of the war effort was nearly wrecked, while at the same time the future was sacrificed to immediate needs and a lack of scientific man-power created from which the country will not recover for many years.

Dr. Bush believes that the lack of a sufficient number of brilliant young men with a basic training in fundamental science will be particularly unfortunate and will severely handicap the Carnegie Institution in the immediate post-war years. While, however, we have had a partial moratorium on the creations of fundamental science, and have caused a deficit of scientific man-power, we have undoubtedly a new stock of dammed-up ideas. This factor, together with the probability of adequate support for scientific effort, makes the vista in science attractive if we can assume a peaceful world. To ensure that the present emphasis on science does not result in unbalance and a neglect of other fields of effort, it is essential to educate fully all the young and brilliant minds that can be found and to present clearly the various callings as young men start their careers, so that none requiring recruits is overlooked, not forgetting that political careers must be made attractive for sound thinkers if democracy is to function effectively in a world of growing complexity.

The Institution, the president reports, has emerged from the War in sound financial condition, with increased endowment, although the rate of income from endowment has dropped severely. It has conducted much war research under contract for the Government, contributing its facilities, its normal overhead and the services of its regular staff, and being reimbursed only for additional staff, equipment and overhead. The salary scale of the Institution requires revision, and a new retirement and insurance plan has been put into operation.

As regards the research activities of the departments and divisions during the year, there is in general little to add to the broad picture given in the previous Yearbook (see *Nature*, 156, 453; 1945). Reference may, however, be made to plans of the Department of Terrestrial Magnetism for the investigation of phenomena of thunderstorms and its investigations of the rate of ionization inside a room. Some results of the attempt of the Division of Zoology of the United States Public Health Service to correlate by radioactive-tracer techniques the localization of heavy metals in the body and their chemotherapeutic activity are reported, as well as ionospheric data obtained at Watheroo and Huancayo Magnetic Observatories. The Division of Plant Biology has found that the antibiotic properties of the material isolated from cultures of the green alga *Chlorella* are due to, or associated with, the presence of unsaturated fatty acids, but the activity only develops on exposure to air and light. Pure unsaturated fatty acids showed the same behaviour, including linoleic, elaidic, β-eleostearic and β-licanic acids. In the Department of Embryology much time has been devoted to the perfection of a new technique of microtomy intended to reduce the distortion of tissues caused by the pressure of the microtome knife, and the position of embryology as a co-operative science is discussed in the report in relation to future work of the Department.

In the Department of Genetics cytogenetic studies reported include the induction of mutations in the short arm of chromosome 9 in maize and preliminary studies of the chromosomes of the fungus *Neurospora crassa*. An extensive investigation of the genetics of acquired bacterial resistance to drugs and other antibacterial agents has been initiated, including work on resistance to penicillin, sulphonamides, inorganic salts, bacteriophages and ultra-violet radiation. Other work has been directed to the development of high-yielding strains of *Penicillium* by submerged culture and of an aerosol method for the chemical treatment of *Drosophila melanogaster*, and work on the cytogenetics of *Drosophila* and the genetic structure of natural populations is also reviewed. The report of the Nutrition Laboratory includes a brief review of the contributions of the Laboratory during the last thirty-eight years, emphasizing the work on the development and testing of apparatus for the measurement of heat production and elimination, respiratory exchange and surface and internal body temperature.

FORTHCOMING EVENTS

(*Meetings marked with an asterisk * are open to the public*)

Tuesday, October 15

BRITISH ECOLOGICAL SOCIETY (at the Royal Society, Burlington House, Piccadilly, London, W.1), at 2.15 p.m.—Discussion on "Survival and Extinction of Flora and Fauna in Glacial and Post-Glacial Times" (to be opened by Dr. Jessen).

BRITISH SOCIETY FOR INTERNATIONAL BIBLIOGRAPHY (at the Institution of Electrical Engineers, Savoy Place, Victoria Embankment, London, W.C.2), at 2.30 p.m.—Dr. B. M. Crowther: "The Use of the Universal Decimal Classification in Periodical Abstracting Services for Scientists and Engineers"; Dr. S. C. Bradford: "The Problem of Complete Documentation in Science and Technology".

LONDON SCHOOL OF ECONOMICS AND POLITICAL SCIENCE (at Houghton Street, Aldwych, London, W.C.2), at 4.45 p.m.—Sir Theodore Gregory: "The Outlook for India"*. (To be repeated on October 21 and 22.)

Wednesday, October 16

INSTITUTE OF FUEL. YORKSHIRE SECTION (at the University, Leeds), at 2.30 p.m.—Dr. A. L. Roberts: "Radiant Heating—its Principles and some Applications".

SOCIETY OF CHEMICAL INDUSTRY, AGRICULTURE GROUP (in the Physical Chemistry Lecture Theatre, Royal College of Science, South Kensington, London, S.W.7), at 2.30 p.m.—Dr. F. Gross: "An Experiment in Farming the Sea"*.

ROYAL MICROSCOPICAL SOCIETY (in the Hastings Hall, B.M.A. House, Tavistock Square, London, W.C.1), at 5 p.m.—Mr. E. Wilfred Taylor: "Improved Image Illumination and Contrast with the Metallurgical Microscope".

INSTITUTION OF ELECTRICAL ENGINEERS, TRANSMISSION SECTION (at Savoy Place, Victoria Embankment, London, W.C.2), at 5.30 p.m.—Mr. J. Andrew Lee: Inaugural Address as Chairman.

INSTITUTE OF PETROLEUM (at 26 Portland Place, London, W.1), at 5.30 p.m.—Mr. A. T. Wilford: "The Lubrication of Pre-Selective Gearboxes".

ROYAL INSTITUTE OF CHEMISTRY, LONDON AND S.E. COUNTIES SECTION (at the London School of Hygiene and Tropical Medicine, Keppel Street, London, W.C.1), at 6.30 p.m.—Discussion on "The Publicity of Science by Radio" (to be opened by Dr. W. E. van Heyningen).

ROYAL INSTITUTE OF CHEMISTRY, NEWCASTLE-UPON-TYNE AND NORTH-EAST COAST SECTION (joint meeting with the SOCIETY OF CHEMICAL INDUSTRY, in the Chemistry Lecture Theatre, King's College, Newcastle-upon-Tyne), at 6.30 p.m.—Lieut.-Colonel A. Wedgwood: "Problems in the Concentration of various Small Sized Minerals".

BRITISH ASSOCIATION OF CHEMISTS, LONDON SECTION (at Gas Industry House, 1 Grosvenor Place, London, S.W.1), at 7 p.m.—Mr. J. H. F. Smith: "Fire and Explosion: 1. Inflammable Concentrations and Ignition Temperatures".

Thursday, October 17

CHEMICAL SOCIETY (joint meetings with the SOUTH YORKSHIRE SECTION OF THE ROYAL INSTITUTE OF CHEMISTRY, the SHEFFIELD METALLURGICAL ASSOCIATION, and the SHEFFIELD UNIVERSITY CHEMICAL SOCIETY, in the General Lecture Theatre, The University, Western Bank, Sheffield), at 2.30 p.m. and 6 p.m.—Prof. Jaroslav Heyrovsky: "The Principles and Applications of Polarography".

INSTITUTE OF FUEL, EAST MIDLAND SECTION (at the Gas Demonstration Theatre, Nottingham), at 3 p.m.—Babcock and Wilcox Film "Steam" (presented by Mr. E. L. Luly).

INSTITUTION OF MINING AND METALLURGY (at the Geological Society, Burlington House, Piccadilly, London, W.1), at 5 p.m.—Major P. L. Teed: "Anglo-American Magnesium Production"; Dr. Anthony Caplan and Mr. J. K. Lindsay: "An Experimental Investigation of the Effects of High Temperatures on the Efficiency of Workers in Deep Mines".

INSTITUTION OF ELECTRICAL ENGINEERS, INSTALLATIONS SECTION (at Savoy Place, Victoria Embankment, London, W.C.2), at 5.30 p.m.—Mr. J. F. Shipley: Inaugural address as Chairman.

SOCIETY OF CHEMICAL INDUSTRY, ROAD AND BUILDING MATERIALS GROUP (joint meeting with the RHEOLOGISTS' CLUB, at Gas Industry House, 1 Grosvenor Place, London, S.W.1), at 6 p.m—Dr. G. W. Scott-Blair: "Rheology and its Application to Road and Building Materials".

CHEMICAL SOCIETY (joint meeting with the PORTSMOUTH AND DISTRICT CHEMICAL SOCIETY, at the Municipal College, Portsmouth), at 7 p.m.—Dr. H. J. Emeléus, F.R.S.: "Chemical Aspects of Work on Atomic Fission".

ROYAL PHOTOGRAPHIC SOCIETY OF GREAT BRITAIN, SCIENTIFIC AND TECHNICAL GROUP (in the Lecture Theatre, Science Museum, Exhibition Road, London, S.W.7), at 7 p.m.—Dr. C. F. Powell: "Photographic Methods in Nuclear Research".

CHEMICAL SOCIETY (at Burlington House, Piccadilly, London, W.1), at 7.30 p.m.—Scientific Papers.

ROYAL SOCIETY OF TROPICAL MEDICINE AND HYGIENE (at Manson House, 26 Portland Place, London, W.1), at 8 p.m.—Dr. C. J. Hackett: "The Clinical Course of Yaws in Uganda", followed by film entitled "Yaws in Uganda".

Friday, October 18

NORTH-EAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS (at the Literary and Philosophical Society, Newcastle-upon-Tyne).—Annual General Meeting.

APPOINTMENTS VACANT

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

DEMONSTRATOR IN THE DEPARTMENT OF MEDICAL ENTOMOLOGY—The Dean, London School of Hygiene and Tropical Medicine, Keppel Street, Gower Street, London, W.C.1 (October 16).

ASSISTANT LECTURER IN AGRICULTURAL CHEMISTRY—The Principal, Midland Agricultural College, Sutton Bonington, Loughborough, Leicestershire (October 19).

LECTURERS (2) IN THE DEPARTMENT OF AGRICULTURE, (a) Specialist in Animal Husbandry, (b) Specialist in Crop Husbandry—The Registrar, University College of Wales, Aberystwyth (October 19).

LECTURER IN ELECTRICAL ENGINEERING—The Clerk to the Governors, Technical College, Infirmary Road, Chesterfield (October 24).

JUNIOR LECTURER IN ELECTRICAL ENGINEERING—The Director, Robert Gordon's Technical College, Aberdeen (October 25).

ASSISTANT LECTURER IN MATHEMATICS—The Registrar, College of Technology, Manchester 1 (October 28).

BIOCHEMIST FOR THE PATHOLOGICAL DEPARTMENT—The House Governor, North Staffordshire Royal Infirmary, Stoke-on-Trent (October 30).

DIRECTOR OF RESEARCH of the Wattle Research Institute, Natal University College, Pietermaritzburg, South Africa—The Secretary, Universities Bureau of the British Empire, 24 Gordon Square, London, W.C.1 (October 31).

SENIOR LECTURERS IN (i) PHYSICS, (ii) GEOGRAPHY, (iii) PHILOSOPHY; LECTURERS IN (i) GEOGRAPHY, (ii) PHILOSOPHY, and a JUNIOR LECTURER IN PHYSICS, for Canterbury University College, Christchurch, New Zealand—The Secretary, Universities Bureau of the British Empire, 24 Gordon Square, London, W.C.1 (October 31).

ASSISTANT PROFESSOR FOR THE DEPARTMENT OF PHYSICS—The President, Dalhousie University, Halifax, Nova Scotia, Canada (November 1).

DEPUTY DIRECTORS (2) OF ROAD RESEARCH, and a SENIOR PRINCIPAL SCIENTIFIC OFFICER, in the Road Research Laboratory of the Department of Scientific and Industrial Research—The Civil Service Commission, 6 Burlington Gardens, London, W.1, quoting No. 1648 (November 7).

DIRECTOR OF ORDNANCE FACTORIES (ENGINEERING)—The Secretary, Ministry of Supply, Est. 8, Room 151, Shell Mex House, Strand, London, W.C.2 (November 14).

CHAIR OF CHEMISTRY at Auckland University College, New Zealand—The Secretary, Universities Bureau of the British Empire, 24 Gordon Square, London, W.C.1 (November 15).

PROFESSORSHIPS IN (i) MATHEMATICS, (ii) PHYSICS—The Registrar, University College, Leicester (November 16).

CHAIR OF CHEMICAL ENGINEERING—The Registrar, University, Sydney, N.S.W., Australia (December 31).

PROFESSOR OF BOTANY at the Imperial College of Tropical Agriculture, Trinidad, B.W.I.—The Secretary, Imperial College of Tropical Agriculture, Grand Buildings, Trafalgar Square, London, W.C.2 (December 31).

ASSISTANT (female) IN THE CLINICAL LABORATORY—The House Governor, Queen Elizabeth Hospital, Birmingham 15.

ASSISTANT EXPERIMENTAL OFFICER at the Atomic Energy Research Establishment of the Ministry of Supply—The Secretary, Ministry of Supply (Est. 8 (c)), Room 193, Shell Mex House, Strand, London, W.C.2.

ASSISTANT LECTURER IN PHYSICS, and a DEMONSTRATOR IN PHYSICS—The Registrar, University College, Nottingham.

HEAD OF THE DEPARTMENT OF CHEMISTRY AND BIOLOGY at the Leeds College of Technology—The Director of Education, Education Office, Leeds 1.

LABORATORY SUPERINTENDENT FOR THE MEDICAL DEPARTMENT of the Government of Nigeria—The Crown Agents for the Colonies, 4 Millbank, London, S.W.1, quoting M/N/17075.

LECTURER IN THE DEPARTMENT OF MATHEMATICS—The Principal, Technical College, Huddersfield.

LECTURER IN ZOOLOGY, and a ASSISTANT LECTURER IN ZOOLOGY—The Secretary, University, Edmund Street, Birmingham 3.

SCIENTIFIC ASSISTANT—The Director, Imperial Bureau of Soil Science, Rothamsted Experimental Station, Harpenden, Herts.

SCIENTIFIC AND EXPERIMENTAL OFFICERS FOR THE STATISTICAL DEPARTMENT—The Secretary, Rothamsted Experimental Station, Harpenden, Herts.

REPORTS and other PUBLICATIONS

(not included in the monthly Books Supplement)

Great Britain and Ireland

Scientific Proceedings of the Royal Dublin Society. Vol. 24 (N.S.), No. 6: Biochemical Analyses with the Spekker Absorptiometer. By Einhart Kawerau. Pp. 63–70. 1*s*. Vol. 24 (N.S.), No. 7: The Possibility of Initiating Thermo-nuclear Reactions under Terrestrial Conditions. By Dr. J. H. J. Poole. Pp. 71–76. 1*s*. Vol. 24 (N.S.), No. 8: The Mechanism of the Formation of Allophanates from Carbamates. By A. E. A. Werner and J. Gray. Pp. 77–84. 1*s*. Vol. 24 (N.S.), No. 9: Dopplerite in Co. Limerick. By M. Dee and G. F. Mitchell. Pp. 85–88. 6*d*. (Dublin: Hodges, Figgis and Co., Ltd.; London: Williams and Norgate, Ltd., 1946.) [165

British Library of Political and Economic Science. Annual Report, 1944–45. Pp. 18. (London: London School of Economic and Political Science, 1946.) [215

Medical Research Council: Industrial Health Research Board. Report No. 89: Artificial Sunlight Treatment in Industry: a Report on the Results of Three Trials—in an Office, a Factory and a Coal-mine. By Dr. Dora Colebrook. Pp. 64. (London: H.M. Stationery Office, 1946.) 1*s*. net. [215

Proceedings of the Aristotelian Society. New Series, Vol. 45: Containing the Papers read before the Society during the Sixty-sixth Session, 1944–1945. Pp. xxv + 206. (London: Harrison and Sons, Ltd., 1945.) 25*s*. net. [215

Other Countries

State of Illinois: Department of Registration and Education, Division of the Natural History Survey. Bulletin, Vol. 21, Article 5: Preliminary Studies on Parasites of Upland Game Birds and Fur-Bearing Mammals in Illinois. By W. Henry Leigh. Pp. iv+185–194. Bulletin, Vol. 21, Articles 6–7: Preliminary Investigation of Oak Diseases in Illinois, by J. Cedric Carter; A Needle Blight of Austrian Pine, by Robert L. Hulbary. Pp. iv+195–236. Bulletin, Vol. 21, Article 8: Duck Food Plants of the Illinois River Valley. By Frank C. Bellrose, Jr. Pp. iv+237–280. Bulletin, Vol. 22, Article 1: The Plant Bugs, or Miridae, of Illinois. By Harry H. Knight. Pp. vi+234. Bulletin, Vol. 23, Article 1: The Caddis Flies, or Trichoptera, of Illinois. By Herbert H. Ross. Pp. vi+326. Bulletin, Vol. 23, Article 2: Duck Populations and Kill; an Evaluation of some Water-fowl Regulations in Illinois. By Frank C. Bellrose, Jr. Pp. iv+327–372. Bulletin, Vol. 23, Article 3: Overfishing in a Small Artificial Lake, Onized Lake near Alton, Illinois. By George W. Bennett. Pp. iv+373–406. Bulletin, Vol. 23, Article 4: Wetwood of Elms. By J. Cedric Carter. Pp. vi+407–448. Bulletin, Vol. 23, Article 5: Fox Squirrels and Gray Squirrels in Illinois. By Louis G. Brown and Lee E. Yeager. Pp. vi+449–526. (Urbana, Ill.: Illinois Natural History Survey, 1940–1945.) [193

Arkiv för Kemi, Mineralogi och Geologi utgivet av K. Svenska Vetenskapsakademien. Band 22A, No. 10: Electrophoresis by the Moving Boundary Method; a Theoretical and Experimental Study. By Harry Svensson. Pp. 156. (Stockholm: Almquist and Wiksells Boktryckeri A.-B., 1946.) [253

Indian Central Cotton Committee: Technological Laboratory. Technological Bulletin, Series B, No. 34: The Analysis, Grading and Utilisation of Indian Linters. By Dr. L. Thoria and Dr. Nazir Ahmad. Pp. 24. (Bombay: Indian Central Cotton Committee, 1943.) 1 rupee. [283

Annual Report of the Imperial Council of Agricultural Research, 1944–45. Pp. 45. (Delhi: Manager of Publications, 1945.) 2.2 rupees: 3*s*. 6*d*. [283

Western Australia: Department of Mines. Report of the Mineralogist, Analyst and Chemist for the Year 1944. Pp. 32. (Perth: Government Printer, 1945.) [24

Pražské Hvězdarny. Č.12: Sur une nouvelle construction de microphotométrie de l'Observatoire de Praha, par František Link; Tables pour la réduction des époques à l'année siderale, par Vladimír Guth. Pp. 14. Č.13: Knihovna astronoma Antonína Strnada ředitele Pražské Hvězdárny (1746–1799). By Otto Seydl. Pp. 78. Č.14: Dioptrische Tafeln der Erdatmosphäre. Von František Link und Zdeněk Sekera. Pp. 28. Č.15: Messungen der atmosphärischen Absorption auf terrestrischer Basis. Von Vladimír Guth und František Link. Pp. 5. Č.16: Über die Fehler einiger Astronomischen Objektive und Spiegel. Von Bohumil Šternberk. Pp. 14. Č.17: Tafeln zur Berechnung der galaktischen Bewegungskomponenten der Sterne. Von František Link. Pp. 48. (Praha: Státní Hvězdárna, 1939–1941.) [34

Annales de l'Institut de Physique du Globe de l'Université de Paris et du Bureau central de Magnétisme terrestre. Tome 19. Publiées par les soins de Prof. Ch. Maurain. Pp. v+183. Tome 20. Publiées par les soins de J. Coulomb. Pp. v+163. Tome 21. Publiées par les soins de J. Coulomb. Pp. iv+145. (Paris: Presses universitaires de France, 1941–1943.) [44

Arkiv för Kemi, Mineralogi och Geologi utgivet av K. Svenska Vetenskapsakademien. Band 23A, No. 1: Studies on Adsorption and Adsorption Analysis with special reference to Homologous Series. By Stig Claesson. Pp. 133. (Stockholm: Almquist and Wiksells Boktryckeri A.-B.; London: H. K. Lewis and Co. Ltd., 1946.) [84

Indian Forest Leaflet. No. 74: The Vegetable Tanning Materials of India, Part 3, Babul (*Acacia arabica* Willd.) By M. V. Edwards. Pp. ii + 21. 8 annas. No. 76: The Vegetable Tanning Materials of India, Part 5, Black Wattle (*Acaria mollissima* Willd.) By M. V. Edwards. Pp. ii + 22. 8 annas. (Dehra Dun: Forest Research Institute, 1945.) [84

League of Nations. Bulletin of the Health Organisation, Vol. 11: Bibliography of the Technical Work of the Health Organisation of the League of Nations, 1920–1945. Pp. 235. (Geneva: League of Nations; London: George Allen and Unwin, Ltd., 1945.) 6*s*. [114

Annals of the New York Academy of Sciences. Vol. 46, Art. 6: Surface Active Agents. By M. L. Anson, R. R. Ackley, Earl K. Fischer, David M. Gans, M. H. Hassialis, Rollin D. Hotchkiss, Donald Price, A. W. Ralston, Leo Shedlovsky and E. I. Valko. Pp. 347–530. (New York: New York Academy of Sciences, 1946.) 2.25 dollars. [154

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