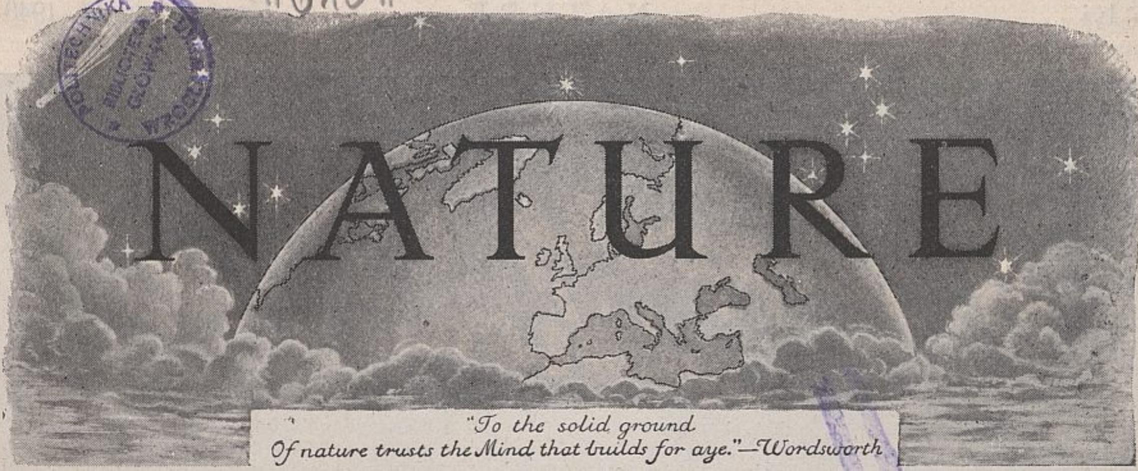

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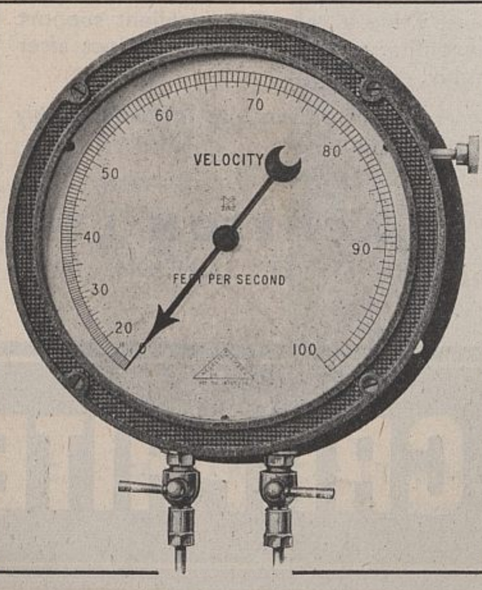

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SCIENTIFIC RESEARCH AND DEVELOPMENT

Research in War-time

THE satisfaction which was felt at the time when the Government announced on September 4 the appointment of three scientific advisers to the Ministry of Production, to complete the organization for scientific research and development, has been somewhat diminished by subsequent changes in the Government itself. The appointments did not, it is true, meet all the criticism that had been advanced of the organization of the scientific resources of Great Britain in furtherance of the war effort, and in particular the demand for the establishment of a whole-time Central Scientific and Technical Board. Further, it was recognized that the success of the new arrangements, including the appointment of Sir Charles Darwin as scientific adviser to the Army Council, depended largely on the right men being chosen to fill the new posts, as well as on the spirit in which the Ministries and Departments would co-operate, as was pointed out by the Select Committee on National Expenditure. None the less, there was a general feeling that the new organization should be given a fair trial before criticizing it too severely.

One of the reasons for welcoming the appointment of the three full-time scientific advisers to the Minister of Production was the statement that they would work under the immediate supervision of the Lord Privy Seal (then Sir Stafford Cripps), acting on behalf of the Minister. With Sir Stafford's appointment as Minister of Aircraft Production, he has now to carry the responsibilities of the administration of a department of crucial importance, and he has also been invested with special responsibilities in regard to the anti-U-boat campaign which must make further large demands on his time. Not only is it therefore unlikely that he will be able to devote the detailed attention to the activities of the new scientific advisers which was expected, but also, since he is no longer a member of the War Cabinet, he can scarcely represent their views to those who are directing the War, at any rate so effectively as scientific workers expected in welcoming the appointments.

For these reasons Sir Stafford Cripps's paper on "Government and Science in Great Britain" at the opening session of the recent conference of the Association of Scientific Workers on "Planning of Science: in War and in Peace" (see NATURE, February 6, p. 152) was awaited with unusual interest. Sir Stafford Cripps's statement, however, proved somewhat disappointing and in general added little to the statements which we have already had on various occasions from Lord Hankey and Lord Chatfield, with which it can fairly be compared. At many levels there is, as Sir Stafford Cripps was able to show, close collaboration, but he admitted that in regard to industrial research there is still room for better integration of research and development with the supply ministries.

Sir Stafford Cripps's statement does suggest, indeed, that we are much nearer securing that the immediate study of strategy and tactics by the General Staff is conducted with an awareness of the possibilities which technical and scientific advance has put in our hands. Nothing in his address, however, goes far to resolve the doubts as to whether we can safely rely on advisory bodies for this purpose, or whether it is necessary that there should be some Central Scientific and Technical Board with executive, rather than advisory, powers. The failure to realize sufficiently early the vital part which science would play in this War, to which Sir Stafford Cripps alluded, is indeed an important consideration which might favour an executive body. Moreover, it has to be remembered that the time factor, which Sir Stafford gives as one reason for not creating a "tidy plan" of scientific organization of the war effort, may be an equally decisive reason in favour of a central scientific body with executive rather than advisory powers. Only so may it be possible on occasion to cut out departmental delays and bring down the interval between discovery and production to months or even weeks, as against the normal lag of years in peacetime.

The proposals advanced by Mr. E. D. Swann on behalf of the executive of the Association of Scientific Workers at the conference stress this vital factor of time and the importance of ensuring that the limited resources of Great Britain are fully used on the most vital problems. They provide for the establishment of a Central Scientific and Technical Board with scientific and technical qualifications and wide executive powers. This Board would be in direct contact with the War Cabinet, which it would advise on scientific matters. It would relate the country's scientific effort to the strategy determined by the War Cabinet.

It cannot be said that Sir Stafford Cripps, any more than Mr. Lyttelton, has shown that such central direction is unnecessary. Admittedly we are still paying the price for our long-continued national neglect of science, with the result that throughout the Fighting Services and in the Civil Service there are far too few in positions of high responsibility competent to assess the scientific and technical factors involved in the day-to-day tactical and strategical problems of the War. Scientific workers are not, of course, in supporting such proposals, advancing the claim to determine policy, though the extent to which policy must be based on scientific and technical considerations tends to increase rather than otherwise. It is, however, their moral responsibility to see to it by all means in their power that those responsible for the formulation of policy give full weight to the scientific and technical factors involved. More they cannot ask ; and to ask for less is a dereliction of duty.

On the whole, it may well be held that the balance of evidence points to some Board possessing executive authority, such as that suggested by the Association, the Parliamentary and Scientific Committee and other bodies, to supplement the work already being done by the Scientific Advisory Committee, the scientific advisers to the Minister of Production, the Engineering Advisory Committee and the numerous other committees, to the activities of which Sir Stafford Cripps referred. At the same time it should be recognized that the personnel of such a board, apart from its status, may well present greater difficulties than at first appear, and that much spade work will be required to ensure that it can function harmoniously and effectively in its numerous departmental relations.

There are two further points, however, which should be noted. In the first place, while Air Chief Marshal Sir Philip Joubert de la Ferte's politer version of the dicta that the expert should be kept on tap, not on top, cannot be gainsaid, there is this much to be observed. Sir Philip rightly said that from the military point of view the ideal is for the Services to state the need and to put the requirements to the scientific man for investigation, but that at no time should the latter exercise judgment over military matters. The real point at issue is this ability of the Fighting Services to formulate their requirements in time, simply because that can now only be done with difficulty, or not at all, by those without sufficient first-hand knowledge of science to be aware at least to some extent of the general trend of scientific advance and its technical possibilities. Without that background, the right questions and problems may not be put to the scientific worker, or, if put, may be put too late. It seems clear that Sir Philip Joubert himself appreciates this weakness, for he admitted that the division of functions is not always clear cut, and that scientific men might be required to elucidate the position by advising on the need itself, as well as the requirements.

The second point relates to British contact with the United States, to which Sir Alfred Egerton's address was devoted. It cannot well be maintained that there is even yet a properly organized central agency for bringing together the work of all the missions to the United States. Even if it possessed no executive authority, a Central Technical and Scientific Board should be able to establish a central information bureau from which scientific and technical liaison could be conducted, so as to ensure that departmental missions are at least in touch with one another, and that those at the centre know what all, and not just a few, of the departments are doing.

The three charts reproduced on pp. 206–207, which are based on diagrams prepared for the Conference, illustrate the war-time organization of scientific effort in Great Britain, the United States and the U.S.S.R.

Research in Peace-time

This Conference of the Association of Scientific Workers, however, was summoned to consider the planning of science in peace as well as in war. Sir Stafford Cripps did well to remind us that there is in reality no difference in the principles that should be applied in time of war and in time of peace. It should also be remembered, however, that to ensure the speedy winning of the war, it may be necessary to adopt measures, in view of our long neglect of science as a nation, which should have no place in the permanent organization when the appropriate steps to repair that neglect have been taken and had effect. The question whether the present organization and utilization of science in Great Britain are adequate to the service of national needs should not be determined solely by reference to war-time conditions. The principles on which that organization is based should be scrutinized in relation to long-term needs and tendencies, and not merely the pragmatism of war.

There is no need here to open a fresh discussion as to whether or not science should be planned. We cannot escape the necessity of planning, broadly, our scientific activities, along with other activities, if we are to ensure a society in which orderly development is possible and the opportunities which scientific advance has given us are to be enjoyed by the many and not by the few. It is not a question of planning or of not planning, but of the extent to which we shall plan, and the limits which are placed on our planning by the necessity for preserving a free society and the freedom of investigation and utterance essential to scientific advance. It is a question of so ordering society as to secure the best conditions for encouraging the highest quality of scientific and of other creative work.

Once this is clearly recognized, the controversy between the planners and those who oppose all planning as inconsistent with the freedom of science is seen to be irrelevant. Freedom for scientific inquiry, as Prof. H. Levy remarked, may be a catch-phrase that confuses the issue and may obstruct advance, even if it does not play into the hands of reactionary movements. Freedom comes by recognizing and overcoming restrictions, not by ignoring them, and scientific workers may well ponder carefully a suggestive passage in Prof. E. H. Barker's great book, "Reflections on Government", in which he discusses, first, the process of democracy itself as an example of the scientific method, and then the authority of natural science and the place of the scientific expert.

The effective prosecution of any adequate reconstruction policy will call for a much more effective utilization of science than in the past, but this emphatically does not mean the regimentation of science. It must involve, however, not simply the allocation of greater resources of material and man-power to scientific and to technical research as well as to training in science, but also to some extent the distribution of those resources where they are most needed in the interests of the community as a whole. It is not only in time of war that advance has been retarded and the solution of problems delayed because of the uneven front of research, and excessive concentration of man-power and resources on particular and even narrow fields. The problem is one of securing a reasonable balance between the different fields of knowledge, not of dictating the problems to which attention shall be given within particular branches of science ; effort must be diverted from time to time to fields which from one cause or another appear to have been neglected, whether through special difficulties or the absence of sufficient incentive in comparison with others. It is no interference with the true freedom of science, for example, for the Government, in greatly extending its encouragement and support of long-range or fundamental research at the universities, to which we look for creative discoveries, to ear-mark its endowments for particular broad fields as, for example, agricultural biology, which have been comparatively neglected in contrast with the related field of nutrition. There must be some means of redressing the balance if society is not to suffer continually from the absence of scientific knowledge at some point which has not been sufficiently attractive to engage the attention of individuals.

It is equally true that there must be some satisfactory relation and balance between such academic research at the universities and that proceeding in industry and in Government departments. No policy of expansion of industrial research or research in Government institutions could be fruitful in the long run if long-range and fundamental research in the universities were starved. Further, both industrial research and research by Government departments are required to apply, for the benefit of the community, the advances in knowledge which come from the universities, apart altogether from the contributions in technique and the stimulation to thought which so often results from contact between workers in the universities and in industry or Government departments. An important aspect of the planning of science is indeed to foster such contacts and the frequent exchange of staff as well as of information. There could be no surer way of developing mutual respect between academic and industrial workers and breaking down misunderstanding and ill-feeling.

Some of the problems in this respect are admirably set forth in the paper which Mr. R. S. Bickle contributed to the discussion on planning after the War. The broad problems of scientific personnel were discussed by Sir Lawrence Bragg, who urged the importance of starting now to plan the university courses and facilities for research which would be required, and clarifying ideas as to the existing institutions which could be used as nuclei for concrete proposals. In regard to personnel, he believes that the Central Register is the right body to watch conditions and to find the men, and that it will be essential to continue it for some years after the War. If the support and advice of the general body of scientific men be given to it, it would solve many problems of post-war placement, of assessing needs, and of regulating conditions. The problem of making use of scientific assets in planning the reconstruction of Great Britain is, he thinks, one of the most difficult of the post-war problems. It involves bringing home to political leaders and Civil Servants the place of science in the new world, bringing them into personal contact with the great leaders of science and firing their imagination with the possibilities of scientific achievement. Without this process of education, we cannot hope to devise the permanent machinery and organization for ensuring the wisest use of scientific and technical resources and the encouragement of fundamental research over the whole front of science.

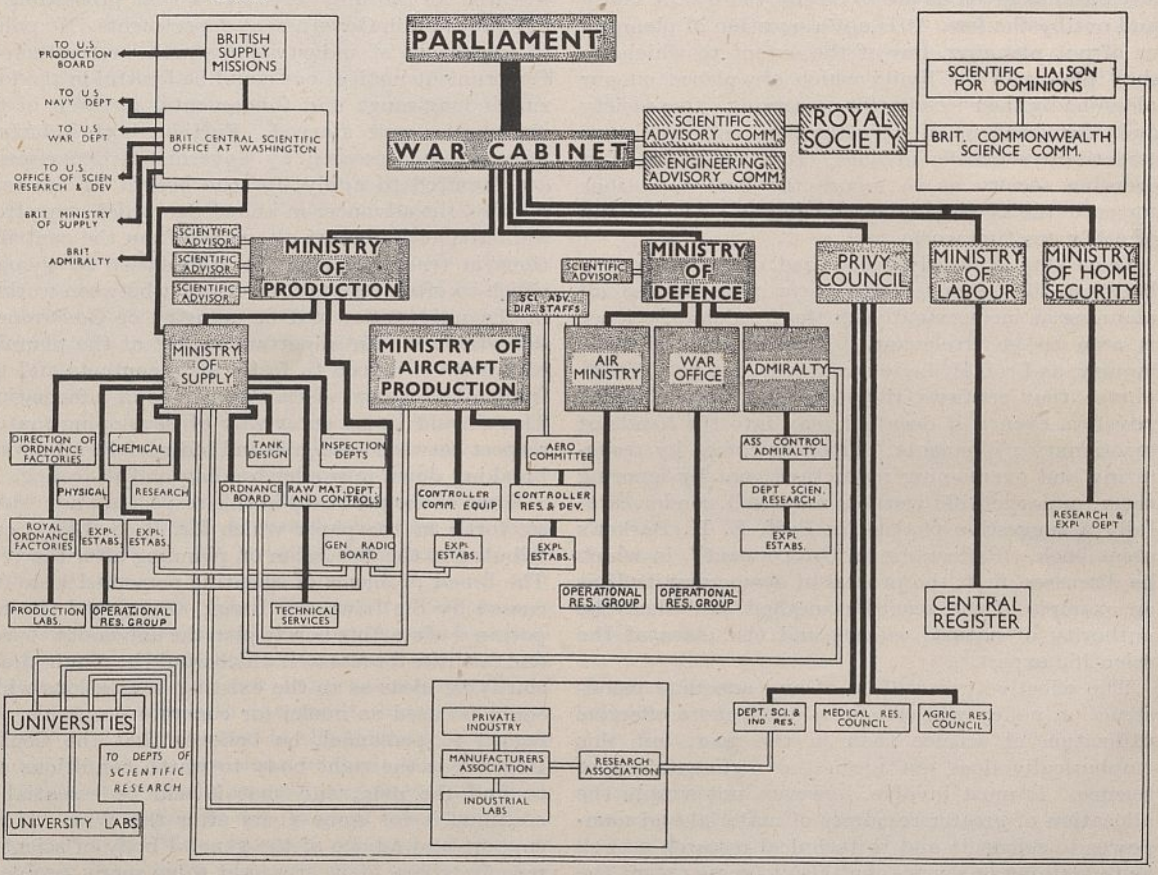
How wide is the range of problems was well shown in Prof. P. M. S. Blackett's paper. Besides the re-education of a large number of younger scientific men and the re-building of fundamental research in the universities and research institutes, including the technical re-equipment of university research laboratories, there are such problems as the future scope and status of the expanded Government research establishments, and the encouragement of close relations between such laboratories, industrial research laboratories and the universities, and the place of the scientific societies in this relationship. Then there is the opening up of scientific relations with other countries and the organization of scientific assistance to liberated countries to help them restart their scientific life.

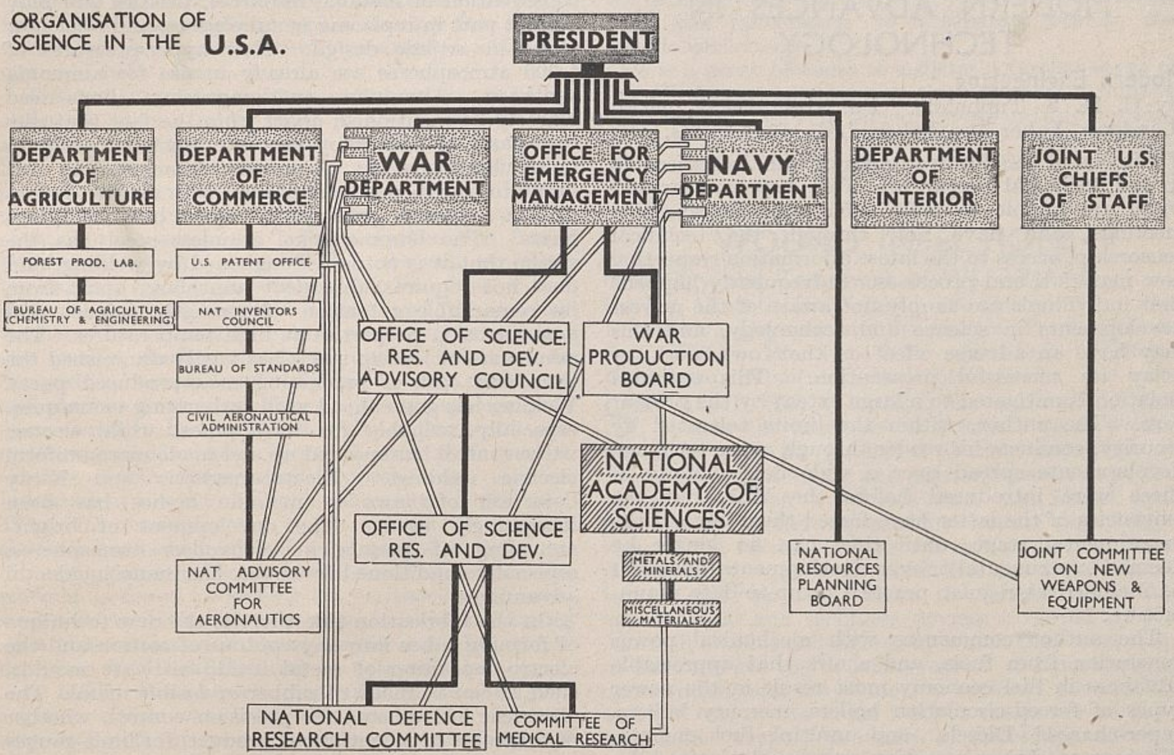
There can be no doubt as to the demands which such problems will make on scientific workers, and the attendance at the conference arranged by the Association of Scientific Workers was welcome evidence that the younger men of science recognize their responsibility towards society as a whole. The effective utilization of science in the war effort and in reconstruction depends not only on the scientific man himself but also on the co-operation of management and workers as well. There has been persistent criticism of shortcomings in production in the reports of the Select Committee on National Expenditure, the Industrial Health Research Board and the Chief Inspector of Factories, of the failure of management to make full use of scientific knowledge which has long been available, in such matters as welfare, lighting, hours of work, safety and the like. If some of the criticism of management at the conference was beside the mark and showed a sad indifference to the principles of scientific administration, the emphasis on the position of the scientific worker in relation to joint advisory committees was indeed timely. More might well have been heard of the importance of this factor of scientific management.

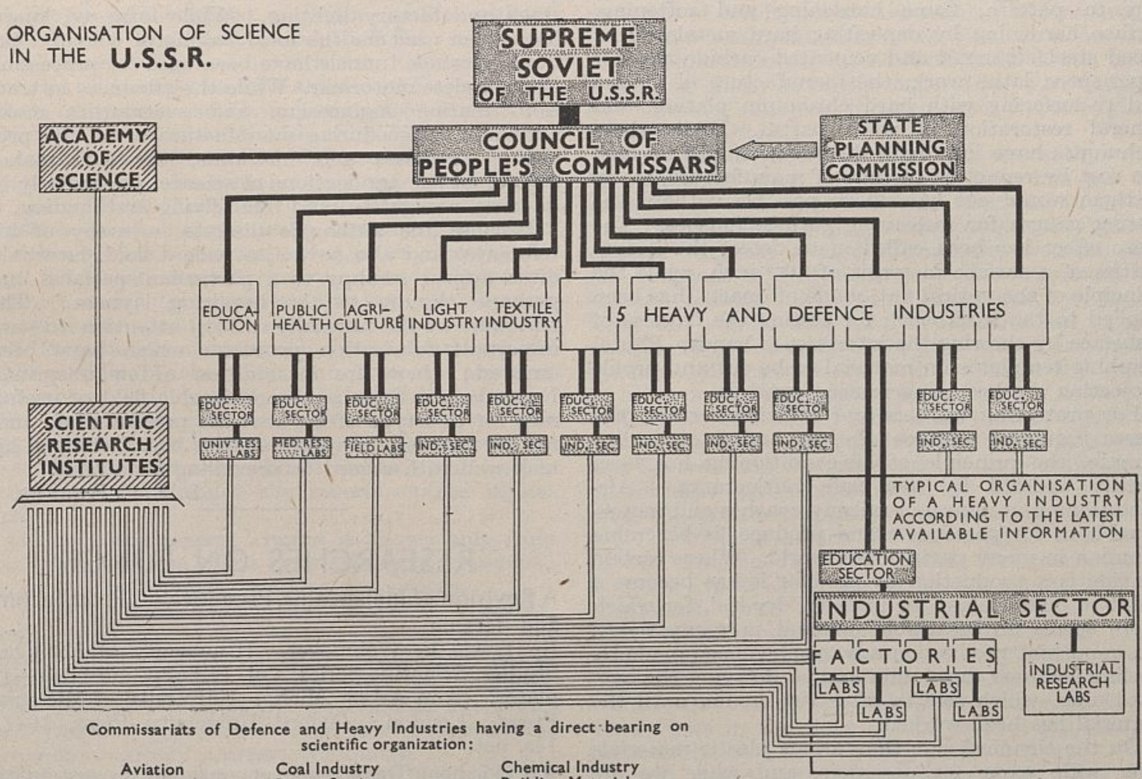
That indeed is the right way, as Sir Robert Watson-Watt pointed out recently, for the scientific worker to demonstrate that he belongs to the Third Estate in a true democracy of production. The scientific method must pervade all stages of production and of use of the product; and the scientific worker must live with the maker and the user. He can only apply the tradition and skill of his craft, however, in direct co-operation with his fellow-craftsman, and that influence will only be exercised when he takes his place as an essential third party, understanding the points of view of both management and labour but bringing his own independent contribution.

The Conference on the Planning of Science will have served its purpose if it stimulates scientific workers, both junior and senior, to think afresh about their place in industry and in society, as well as of the functions and scope of science.

ORGANISATION OF SCIENCE IN THE **U.K.**







Commissariats of Defence and Heavy Industries having a direct bearing on scientific organization:

Aviation	Coal Industry	Chemical Industry
Armaments	Power Stations	Building Materials
Munitions	Electrical Engineering	Medium Engineering
Shipbuilding	Heavy Metallurgy	General Engineering
Oil Industry	Light Metallurgy	Heavy Engineering

MODERN ADVANCES IN TECHNOLOGY

Modern Engineering

By C. H. S. Tupholme. Pp. xi+201+23 plates. (London: Faber and Faber, Ltd., 1942.) 15s. net.

IT is one of the disadvantages of war that scientific and technical people are often dispersed far and wide, are unable to meet each other at scientific meetings, and have not, through the technical censorship, access to the latest information respecting new materials and processes. It frequently happens that individuals are simply not aware of the newest developments in science and technology, and this may have an adverse effect on their own work, or delay its successful prosecution. This enforced isolation is mitigated to a large extent by the present text. The author, within the limits tolerated by security, conducts his reader through many technical developments spread over a wide field. Many of these were introduced before the War, but the exigencies of the latter have forced them beyond the experimental stage, until they can no longer be deemed experimental or even developments, but must be included as regular practice in up-to-date manufacture.

The author commences with mechanical power generation from fuels, and shows that appreciable advances in fuel economy must result in the newer types of forced-circulation boilers, mercury boilers, super-charged Diesels, and multiple-fuel engines. Whereas workshop practice was revolutionized by precision grinding, even greater changes have been brought about by automatic oxygen-cutting of forgings to pattern, flame hardening and softening, surface hardening by depositing hard metals, high-speed steel, diamond and cemented carbide tips for super-speed lathe work, the manufacture of gauges and re-surfacing with hard chromium plating, and general restoration of worn parts. While these techniques have improved the product, and lowered the cost by reduction in time of manufacture, many of them would not have been possible without the testing gauges for measuring surface finishes. The piezo effect has been called in to detect the irregularities of a surface in terms of 10^{-6} inch, while the principle of the optical flat, made of quartz, has been applied to the workbench for testing the flatness of a surface by showing the interference bands. Photographing templates on material to be cut and profile projection are becoming routine practice.

For protecting workers and utilizing certain processes requiring absence of dust and a controlled climate, the principle of air-conditioning has been greatly assisted by new safe refrigerants. Air-conditioning in mines, in railway coaches and motor-cars, both for passengers and produce, is becoming common in many parts of the world. Where carbon dioxide is a production by-product it has become a habit to install plant for making 'dry-ice', for which there seems an insatiable demand in many fields. An important production advance has been made by cooling softened duralumin and so delaying the age-hardening, which sets in after two hours, until the material has been worked.

On the chemical side the various plastic materials offer wide scope for designers, and while we are warned by the plastics industry not to be too optimistic about the wholesale replacement of metal parts by plastics, it is obvious that for economy, lightness and conservation of metallic resources, plastics will play a great part in replacing metal objects, and offer new scope in artistic design. New hyper-pressures of 1,000 atmospheres are already in use for ammonia synthesis. Aluminium and magnesium alloys need scarcely be mentioned, apart from the fact that die-cast parts of light-alloy can be designed to require no machine-finishing. A new development is to clad duralumin with pure aluminium, with marked reduction in corrosion, particularly in the hulls of flying-boats. The chrome-nickel stainless steel has the virtue that it is actually toughened by welding, and does not require subsequent annealing, apart from its remarkable retention of strength, impact and anti-corrosion properties at high temperatures. The admixture of lead to steels has vastly diminished the time and cost of machining mass-produced parts. Welding has gone ahead with carburizing techniques, especially valuable for long pipes, while electric valve control has speeded up and made more uniform electric welding. Electro-magnetic and X-ray detection of flaws in metallic bodies has been increasingly used. The development of bright-annealing of metals in controlled atmospheres, especially conditioned town-gas, has many incidental advantages.

On the fabrication side there is the new technique of forming tubes into any contour of section and the electro-deposition of metal inside intricate moulds, such as can be made of rubber or fusible metal. The electrical instruments for precision control, whether of thickness of a continuous product, for limit-gauges or combustion recording, are endless; fluorescent lamps find applications for sterilizing air in schools and factories, detecting manuscript frauds, and for stage and factory lighting. While infra-red lamps have been used for the local baking of coloured car finishes, whole tunnels have been used for processing the complete motor-car. While the advances in traction, marine engineering, and aeronautics make abundant usage during manufacture of all the preceding processes and materials, the last makes several *ad hoc* applications of science, particularly in de-icing, navigation, and blind-flying and landing.

Because the author is discrete in many of his references and also covers so wide a field, he would often appear scrappy to a particular specialist and perhaps obscure to the inquiring layman. The reviewer would normally direct attention to two important fabrication processes which have been omitted; there are in addition a few misprints. Nevertheless, there is a considerable field of usefulness for this type of book at the present time, and, in this type of survey, the author has discharged his task well with regard to prevailing conditions.

L. E. C. HUGHES.

RESEARCHES ON FUNGI

A Revision of Melanconis, Pseudovalsa, Prosthecium and Titania

By Lewis E. Wehmeyer. (University of Michigan Studies, Scientific Series, Vol. 14.) Pp. viii+161+11 plates. (Ann Arbor, Mich.: University of Michigan Press; London: Oxford University Press, 1941.) 14s. net.

IN this book Dr. Wehmeyer continues his systematic revision of the stromatic Pyrenomycetes, which commenced with his "The Genus Diaporthe and its Segregates" published in 1933. The species concerned are nearly all found in the bark of broad-leaved trees of the northern hemisphere, and with very few exceptions each is characteristically associated with one genus of host plants.

The perithecia are formed in groups in or below stromata which, unlike those of Diaporthe, are not normally associated with black zones of fungus tissue. The primary characters that have traditionally served for distributing the species into different genera are the colour, the septation and the appendages of the ascospores. Often locules are found within the young stromata, or acervuli on their flanks, and from these are produced conidia of two sorts, the broad so-called alpha- and the narrow beta-conidia. Partly through ignorance of the facts, and partly, despite the facts, out of deference to Saccardo's monumental "Sylloge", the perithecia and the two sorts of conidia of the same species have often enough been studied independently of one another; and so have acquired each their vested interest in the systematist's apprehension, and an independent name in his schizophrenic nomenclature. Thus, for example, the single species *Melanconis thelebola* has been made the type species of the three following genera: *Pseudovalsella* von Höhnel for use when it is found producing its perithecia; *Hendersoniopsis* von Höhnel for use when it is found forming its alpha-conidia, and *Cytosporopsis* von Höhnel for use when it is found forming its beta-conidia.

It is Dr. Wehmeyer's particular mission to join together again what has been so unnaturally put asunder; and this he accomplishes by describing and often figuring each available species in all its known forms. He has included under Melanconis all the relevant species with one-septate ascospores, whether hyaline or dark-coloured, and either with or without appendages; and has grouped them into a number of proposed subgenera. Of these, Eu-melanconsis includes all the species with alpha-conidia one-celled, brown or hyaline, and borne in open acervuli—as, for example, the abundant British *M. stilbosum* on birch. Massariovalsa with similar alpha-conidia which are immersed in locules contains only two species, both of them North American; and Pseudomelanconis contains the species with many septate alpha-conidia of either of the Coryneum (that is, of the dry spored), or of the Steganosporium (that is, of the slimy spored) type. Pseudovalsa is restricted to take three species all with unappendaged several-septate ascospores, and fuscous stromata which bear several-septate alpha-conidia of the Coryneum type on an open hymenium. It includes the abundant British *Pseudovalsa lanciformis* on birch. Prosthecium, as here employed to take seven species, has several-septate appendaged ascospores, and stromata which bear in open or closed locules the several-septate alpha-conidia.

Of the other genera, Titania is known only from the type collection of its type species, *T. vesuvius*; its asci each contain only a single ascospore.

In an appendix, the genus Calospora is revised away on the ground that its first species is a Melanconis; all the species included at various times in the genus have been examined and re-distributed. Thus *Calospora platanoides*, well known in Britain on sycamore, appears earlier in this monograph as *Prosthecium innesii* (Currey) Wehmeyer.

The genera Massaria, Aglaospora, Thyridaria and Pseudotrichia differ from all the foregoing in the presence, between the asci, of numerous filiform persistent paraphyses; the author, however, is not yet satisfied that this character justifies their transfer from the Sphæriaceæ to a separate family, the Pseudosphæriaceæ.

It is a great pleasure to register a further stage of Dr. Wehmeyer's progress through the stromatic Sphæriaceæ. The very difficult group of Didymosporæ are now as good as done; and the Phragmosporæ are more than well begun. E. W. MASON.

WOUND INFECTIONS

Pathology and Treatment of War Wounds

By Sir Almroth E. Wright. (Researches from the Inoculation Department, St. Mary's Hospital, London, W.2.) Pp. viii+208. (London: William Heinemann (Medical Books), Ltd., 1942.) 21*s*. net.

SIR ALMROTH WRIGHT has collected in this volume the addresses and papers upon wound infection that he published during the War of 1914–18. It is a fitting and salutary memorial of the pioneer work on a subject that was forced into prominence by the unprecedented casualties of that war. It is fitting because we can assess the large proportion of that work which has stood the test of time: and we can admire the brilliance of the experimental and technical devices invented by Sir Almroth and his colleagues, by which they were able to demonstrate the defensive action of leucocytes in open wounds and the connexion between 'corruption' and the loss in the tissue fluid of the power to neutralize the 'tryptic' processes of infection; and by which they defined the conditions in which a merely contaminated wound would flare up into gas gangrene, and measured the efficacy of the available methods of antibacterial treatment. It is salutary for its few examples of how too close an adherence to a technical approach, however fruitful, can be a stumbling block, as in the exploration of acidosis in the wounded subject by titrations in soft glass capillary pipettes.

It is obvious, however, that both the author and his publishers have not chosen a time like this to publish a volume that was only memorial in intention. *Streptococcus pyogenes* and *Staphylococcus aureus* are still bugbears of civil and military wounds, and gas gangrene is still with us. The treatment of infected wounds still presents many unsolved problems, and a great deal that Sir Almroth has taught deserves to be lifted out of the archives and set under the noses of surgeons and pathologists to-day. But as a lesson to a younger generation the collection would have been better for a little editing, if only to remove the occasional repetitions of experiments and text figures; and the force and precision with which the minutiæ of the experiments are displayed sometimes obscure the emphasis of the main argument.

A collection of papers like this needs a summary. Of his views in 1919, the author has presented a masterly exposition in the chapter on the physiology of wounds, which all who are concerned with the treatment of wounds would do well to read. The case for 'physiological' as against 'antiseptic' treatment still stands, but it does not stand quite so firmly. One would have liked an interpretation of these views in the light of our present knowledge, particularly in chemotherapy and antisepsis. Sir Almroth might with some justice reply that our present knowledge is still too chaotic for a synthesis; nevertheless it would have been valuable if he had attempted it. A. A. MILES.

SENSITOMETRY SINCE HURTER AND DRIFFIELD*

By DR. S. O. RAWLING

THE best memorial to Hurter and Driffield is the continued application of their teaching by the photographic industry. The basis of photographic sensitometry is a characteristic curve of the material under test, and when we remember that the particular characteristic curve in use to-day is still known as the 'H and D curve', obtained by plotting density against the logarithm of the exposure, we realize the excellence of the work which was done so long ago by those two enthusiastic amateurs. The principle of sensitometry remains what it was when Hurter and Driffield left it. The details have changed; the values of the co-ordinates of the curve have been corrected and brought nearer to standardization; new apparatus has been applied to the work and the results themselves are interpreted in new ways which make it possible to link sensitometry much more closely with practical photography. I propose to sketch in outline some of the ways in which the H and D curve has been pulled into shape in order the better to guide those who use photography and those who must provide the best kind of photographic material for each particular purpose.

It is almost fifty-three years since Hurter and Driffield published what was probably the most important of their papers[1]. This was entitled "Photo-chemical Investigations and a New Method of Determination of the Sensitiveness of Photographic Plates" (*J. Soc. Chem. Ind.*, May 31, 1890). In this paper they described shortly the "laws of absorption of light by opaque black substances" and defined the meaning which they attached to the terms opacity, transparency and density of a negative. They stated their opinion that "a negative is theoretically perfect when the amount of light transmitted through its various gradations is in inverse ratio to that which the corresponding parts of the original subject sent out". They described a photometer for measuring density and went on to report on the behaviour of photographic plates, using this instrument for measuring the response of the plates to exposure and development. The general shape of characteristic curves was demonstrated, and from this they put forward their doctrine of how to obtain negatives which by their definition should be perfect. Lastly, they described a method of calculating photographic speed values from characteristic curves.

My argument will be found to arrange itself quite naturally about the H and D curve. To begin with the density axis, there came early difficulty. The first note of 'trouble' was sounded in 1891 by Hurter and Driffield themselves in a paper[2] on the "Relation between Negatives and their Positives". Using density values determined on their own photometer, they found that the effects of exposures to light behind the negatives were greater than those calculated directly from the densities as measured. They supposed that this was caused by light reflected from the surface of the printing material, and that part of this light was then reflected back again by the negative on to the printing material. They summarized their observations thus: "The coefficient a which converts the density as measured, into the printing density, is, for negatives developed by ferrous oxalate, usually a fraction; for pyro developed negatives it is generally nearly 1, if the negatives be used for contact printing; but when the negative is used for enlarging the factor a . . . is always greater than 1, even for negatives developed with ferrous oxalate".

Some values of a found for contact printing were 0·8, 0·665, 0·577. The principal cause of the wide disparity between these values of a and unity was, however, not 'inter-reflection' of light in the printing process, but the unaccounted loss of light by scatter from the negative in their photometer.

Abney directed their attention to the scattering power of negatives, and tried to show that their photometer might not be giving the true optical density. A lively argument followed, from which Hurter and Driffield emerged at last admitting that "the Captain is not yet satisfied that our photometer gives the true optical density" and adding that "density, however expressed, will need different corrections for different operations". Even in this incident we must admit the prophetic nature of their last remark, which was the expression of a truth not always appreciated at the present time.

Abney was right about the scattering of light. The error caused by inter-reflection was small compared with that caused by scatter. Hurter and Driffield's photometer employed direct beams of light between two lamps and a grease-spot photometer, the negative being inserted in one of the beams. Some of the light transmitted by the negative was scattered out of the direct path and never reached the grease-spot. Thus the instrument recorded density values which were too high.

By integrating the whole of the light transmitted by the negative, density values closely approaching contact printing densities are obtained. In general practice, a sheet of white opal glass in contact with the negative serves very well as an integrator, and most of the densitometers now in use employ this device.

Density measurement has not yet been standardized, though with well-designed contact opal densitometers it is possible to compare results obtained in various laboratories without finding serious discrepancies. The comparison is, of course, limited to contact printing technique, and if negatives are to be used in any other way the original caution of Hurter and Driffield must be taken into account: "density . . . will need different corrections for different operations".

The movement towards standardization of sensitometric technique has been most marked in the establishment of standard light sources for sensitometers. The candle and other flame sources have become obsolete, and in their places are electric lamps run at specified colour temperatures.

The commonly used, substandard, vacuum lamp of the photometry laboratories is capable of working well at a colour temperature of 2,360° on the Kelvin scale of temperature, and it was finally decided that such a lamp should be adopted as part of the standard light source for photography. The choice of 2360° K. appears to have followed from the fact that this was supposed to be the colour temperature of the acetylene flame, which had been used with a correcting filter to imitate sunlight.

The 2360° K. light was, however, not adopted as a complete standard. It was capable of much higher output than the candle and it was relatively richer

* Substance of the Hurter and Driffield Memorial Lecture of the Royal Photographic Society, delivered on November 28. The lecture is being published in full in the *Photographic Journal*.

in blue light, but photographic technicians craved for a more evenly balanced distribution of energy such as occurs in direct sunlight. The improvement demanded was not to be gained without sacrifice. It was necessary to filter out the excess of green and red light. The experience of the standardizing laboratories was used in selecting the suitable filter, and after a considerable amount of argument the choice was made from a large series of filters devised and specified by Davis and Gibson[3], of the American Bureau of Standards. This filter converts light from a colour temperature of 2360° K. to the approximate quality of mean noon sunlight at Washington. Thus we are in possession of the specification of a standard light source which can be realized very easily in the laboratory, which gives a fairly even distribution of energy over most of the visible part of the spectrum, and satisfies those who cry for 'artificial sunlight'. In passing, it may be noted that the extreme variations in the quality of real daylight are probably almost as great as between ordinary electric light and mean noon sunlight. For example, the light from clear blue sky is almost as weak in red as the electric light is weak in blue. Nevertheless, the compromise adopted for laboratory work must be considered as a very reasonable one.

Recently there has been found a need for light sources of very much higher power. The substandard photometric lamps are vacuum lamps and cannot be run at temperatures much above 2360° K., and their total candle-power is in the neighbourhood of 30. The invention of the gas-filled lamp has provided lamps which can be run for long periods at a temperature of about 2850° K. without much change in output. It is quite common to develop several hundred candle-power in a single small lamp of this kind, and there is available another Davis and Gibson filter which converts 2848° K. (say, 2850° K.) to mean noon sunlight. This filter, since it has not such a wide gap of colour temperature to bridge, has a considerably higher transmission; thus the resulting laboratory sample of mean noon sunlight is of far higher available candle-power than that of the 2360° K. source with its appropriate filter.

The establishment of a standard light source has been one of the most valuable results of all the efforts which have been made towards standardization of sensitometric methods. It is, however, far from being the only factor controlling the abscissæ values of the characteristic curve. Exposure, being a product of time and intensity, introduces the question of which of the factors is to be varied in giving the series of test exposures necessary for determining the characteristic curve of the material under test. Hurter and Driffield, probably for convenience, varied time, keeping intensity constant; we now call this a 'time scale' method. They assumed that the results would have been the same if time had been kept constant and the intensity had been varied. But reciprocal variation of time and intensity does not always produce equivalent photographic results. In pictorial photography the varying tones in a given negative are all produced by exposure for the same time (determined by the shutter) to a series of intensities determined by the brightness of the various parts of the image in the camera. It seems, therefore, that the ideal system would be to use an intensity scale in sensitometry. This, however, is easier said than done. On the other hand, time-scale sensitometers are easy to specify and can be constructed with great precision. They have accordingly found great favour in certain applications; for example, they are admirable in providing a scale of exposures for the test negatives employed for checking the performance of developers and developing machines; they are also excellent for checking the uniformity of production of photographic materials. Their main limitation is that they do not give reliable information about the performance of different materials in the camera. The trend has therefore been, in studying the behaviour of different materials in practice, to use so far as possible intensity-scale sensitometers at times of exposure comparable with those employed in the camera.

There are two main difficulties in devising a sensitometer to work on the intensity scale principle. The first of these is the enormous waste of light in providing a wide scale of intensity. The unmodulated light must be of high power in order that the lowest intensity of the scale shall be adequate. It is not uncommon for the last step of a sample exposed in a sensitometer of this type to receive less than one thousandth part of the light received by the first. The second difficulty is that of providing means for varying the intensity over a sufficient range without introducing some change in the quality of the light. The common way of referring to this is to say that it is difficult to make a *neutral* intensity modulator. The common gelatin wedges devised by Goldberg[4] were made of such materials as India ink mixed with bluish dyes to give a reasonable approximation to visual neutrality. They were, however, more heavily absorbing in the blue, violet and near ultra-violet, and more transparent to red and infra-red, than in other regions of the spectrum, and, when employed without proper consideration for this fact, have led to some very misleading conclusions. Other materials, such as highly dispersed graphite and developed emulsion, have been used for casting wedges, but no very satisfactory material for casting really neutral wedges has yet been made available. Stepped wedges can, however, be made by exposing photographic plates in stepwise manner and then developing them. Such wedges are usually sufficiently neutral for ordinary sensitometry.

We have now come to the interpretation of results of sensitometric measurements. Hurter and Driffield considered the photographic speed of a negative material in terms of the minimum exposure necessary to record the deepest black of a scene on the lower extremity of the straight line region of the characteristic curve. It is true that their graphical method of determining speed necessarily implied the inclusion of a little of the foot of the characteristic curve where the slope is changing and is less than that of the straight line, but with the negative materials which they favoured the amount of the foot so included was small, and we must admit that these negatives conformed very closely to *their definition* of a perfect negative if we ignore, as they did, the distortion of tone produced in the image by scattered light within the lens and camera.

One conclusion which has been drawn from the theory of tone reproduction is that, for true tone reproduction *in the print* made from a negative, the product of the slopes of negative curve and positive curve should be unity. Now in making prints on paper it is, more often than not, desirable to use almost the whole tone range of the paper from nearly clear white to a density approaching the maximum black possible. Thus the whole of the characteristic curve of the paper comes into play, and since this curve really is 'curved' and not a straight line for the whole of its course, a complication of the Hurter and Driffield doctrine results. To obtain a perfect print, the angle of slope of each part of the negative curve must be complementary to that of the corresponding part of the paper curve. The highlights of the scene correspond with the darkest part of the negative and with the lightest parts of the print which are recorded on the least sloping part of the characteristic curve of the paper. The negative record of this part of the scene should therefore be on the most steeply sloping parts of the negative curve. At the other end of the brightness scale of the scene the deepest shadows are recorded near the deepest black of the paper where the slope of the paper curve is greatest. This part of the scene will be recorded at a lower density region of the negative curve, and it follows that the slope of this part ought to be lower than of that part of the curve corresponding with the highlights. Thus the negative should include part of what Hurter and Driffield called the under-exposure region of the curve.

The problem is to decide how much of the lower part of the negative curve should be included. As an experimental argument, let us try whether the question may be answered by selecting as a limit that point on the negative curve where the angle of slope is the exact complement of the slope of the paper curve in the region which is to depict the shadows of the scene. With a very large proportion of present-day printing papers, the region of the characteristic curve used for the greater part of the shadows is that of maximum slope ; and this is generally related, roughly at any rate, directly with the contrast-giving power of the paper. By using the 'hardest' printing paper available, it will be possible to creep down a very long way into the foot of the negative curve and still obtain true tone reproduction in the deep shadow regions of the print. Meanwhile, however, what has happened to the remainder of the tone scale ? The choice of the hardest available printing paper will bring with it the difficulty that the whole tone scale of the paper will be brought into action by a very small density range in the negative, and our print, while recording the deepest shadows with accuracy, may exaggerate the middle tone differences and record all the highlights as blank white paper. Thus the limit of our creep down the negative curve in search of speed must be set not only by the conditions necessary for reproducing shadow detail but also by the total density range of the negative. The latter is the main factor which determines the contrast grade of the paper which must be used in printing, a fact very well understood by Hurter and Driffield themselves. The contrast grade of a printing paper may indeed be fairly accurately expressed in terms of the negative density range which it will accommodate[5].

The slope of the curve of the selected printing paper must therefore depend on the density range of the negative from which the print is to be made. The smaller the density range of the negative, the greater must be the slope of the paper curve and vice versa. Our first attempt at deciding how far we may creep into the 'under-exposure' region of the curve has thus failed, unless we first choose a printing paper of the correct exposure range (correct contrast grade) for the negative concerned.

Photographic 'speed' of a negative material thus appears to depend not only on the power to record shadow detail, but also on the density range produced in the negative by the whole scene, that is to say, upon the contrast of the negative as a whole.

As a rule, the main pictorial interest of a photograph does not lie in the extremes of the tone-range but somewhere near the middle, and we are generally satisfied with a print in which extreme shadows are lacking in a little of their detail. That is to say, instead of insisting on perfect tone reproduction in the shadows, we can there accept some compression of the tone-scale, and the product of the slopes of the negative and positive curves can be less than unity.

We must, however, satisfy the general condition that the density-range of the negative and the contrast grade of the paper must be suited to one another. L. A. Jones has, during the past few years, made a thorough investigation of this problem, and has suggested as a criterion of speed for ordinary pictorial negative materials the exposure corresponding with that point on the characteristic curve where the gradient is 0·3 of the average gradient for a negative recording an image brightness-range of 32.

Jones[6] has tested this criterion by a statistical method. He prepared a number of transparencies of landscapes to serve as laboratory originals for his experiments. His use of one of these transparencies will serve to explain his method. A series of negatives having progressive increase of exposure was made upon each of a number of negative materials. From each negative the best possible print was made, using for each the most suitable available grade of printing paper. Thus for each negative a series of prints was obtained. The quality of these prints varied from quite unacceptable through just acceptable to excellent. Jones employed a group of about two hundred observers to answer the question : which, in the series of prints arranged in order of increasing negative exposure, was the first one which could be called excellent ? The majority vote was taken for each series and so the minimum camera exposure necessary to yield *the first excellent print* was established for each negative material. This was eventually done for more than seventy negative materials and for several scenes, and made it possible to establish the relative working speeds of the materials as judged on pictorial results by the average observer. These results were then used as the established yard stick with which sensitometric determinations of speed could be compared.

The comparison between the statistical practical estimate of speed as determined by the selection of the first excellent print and the speed as measured by the fractional gradient method gave a total spread of 0·17 on the logarithmic scale. That is to say, taking the extremes, two films which are really alike in speed would be judged to have speed values not more erroneous than by a factor of antilog 0·17, that is, 1·5, if their speeds were calculated by the sensitometric method. This criterion is still 'under observation' by various standardizing committees.

I began with some discussion about the influence of scattered light upon the value of density. I end by directing attention to the influence of the camera and its lens in scattering light all over the image formed on the negative material. This light is often much stronger than is commonly supposed. It has the effect of distorting the brightness scale of the image in relation to the brightness scale of the scene. It was ignored by Hurter and Driffield, but has been discussed and investigated by various workers, of whom I should mention Goldberg[4] and more recently Jones[7].

This sketch cannot claim to be a full historical record of the progress of sensitometry since 1890, but I believe that it indicates the principal lines of progress, and provides the necessary starting points from which a student may go on to study in greater detail the science of photographic sensitometry.

[1] Hurter and Driffield, *J. Soc. Chem. Ind.*, **9**, 455 (1890). H. and D. Memorial Vol., p. 76.

[2] Hurter and Driffield, *J. Soc. Chem. Ind.*, **10**, 100 (1891). H. and D. Memorial Vol., p. 163.

[3] Davis and Gibson, *Mis. Pub.* No. 114, Bureau of Standards, Washington, D.C.

[4] Goldberg, "The Formation of the Photographic Image" (French edition, Paul Montel, Paris).

[5] Chilton, *Phot. J.*, **82**, 151 (1942). Romer and Rajski, *Phot. J.*, **82**, 66 (1942).

[6] Jones and Nelson, *J. Opt. Soc. Amer.*, **30**, 93 (1940); *Phot. J.*, **80**, 152 (1940).

[7] Jones and Condit, *J. Opt. Soc. Amer.*, **31**, 651 (1941).

OBSERVATIONS ON THE PHYSIOLOGY OF COLOUR VISION

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THE recent article by Granit[1] stimulates further thoughts upon the mechanism of colour vision, and his results may perhaps be interpreted in a slightly different manner.

There seems to be little reason to doubt that the appreciation of colour, as distinct from light intensity, must depend upon the presence in the retina of at least two elements of unequal sensitivity to the various wave-lengths of the visible spectrum. Two possibilities are therefore open. The first is that if we assume colour vision to be entirely mediated by cones, and the current views upon the structure and behaviour of the fovea give support to this assumption, we must postulate two or more types of cone or of cone sensitivity and trust that further research may lead to their actual demonstration. As the position stands to-day, apart from the existence of coloured globules in the cones of certain birds and marsupials, and apart from the extraction of a pigment, or pigments, with three distinct absorption bands from the retinæ of certain snakes[2], there is no histological evidence which speaks unequivocally in favour of the presence of different cone types distributed in the retinæ of higher vertebrates or of man in such a way as to be consistent with the facts of colour vision. Theoretical curves, expressing the sensitivity of hypothetical cone types (blue, green and red receptors) to different regions of the spectrum, have been constructed[3], but in order that they should satisfy all the necessary conditions the curves have to be so nearly identical in form and position that it is difficult to believe that any neural mechanism could be so delicately adjusted as to be able to appreciate the subtle differences of cone sensitivity which these curves indicate.

The second possibility is that the elements required for colour vision are those which are known actually to exist in the retina, namely, the rods and the cones. Owing to the peculiar structure of the fovea, which is believed to be rod-free, and to the general, though not universal, absence of Purkinje shift from this area, nearly all theories of colour vision have been based on the first possibility and the alternative hypothesis has received but scant attention. Nevertheless, it has several points in its favour and, since there are certain facts which fit more aptly into such a scheme than into others, it may be well to reconsider the hypothesis.

The functional sensitivity of the rods is indicated by the scotopic ocular visibility curve[4]. Their actual sensitivity has probably been most accurately expressed by the scotopic retinal visibility curve in terms of quanta obtained by Ludvigh[5], which among other things makes allowance for the absorption by the eye media. The maximum sensitivity of the rods lies at about 500 mμ, and the curve shows remarkable resemblance to the absorption spectrum of visual purple. Although the curve is normally obtained under conditions in which large quantities of this substance are present in the rods, there is no reason for believing that the differential sensitivity of the rods to different wave-lengths would change under daylight conditions when most, but probably not all, of the visual purple has been bleached. Indeed, Granit[1] has adduced evidence to show that, at any rate in guinea pigs, the rods do function in daylight and with the same differential sensitivity. Dark adaptation and the power to accumulate large quantities of visual purple in the rods may well be a secondary specialization of a more fundamental rod activity.

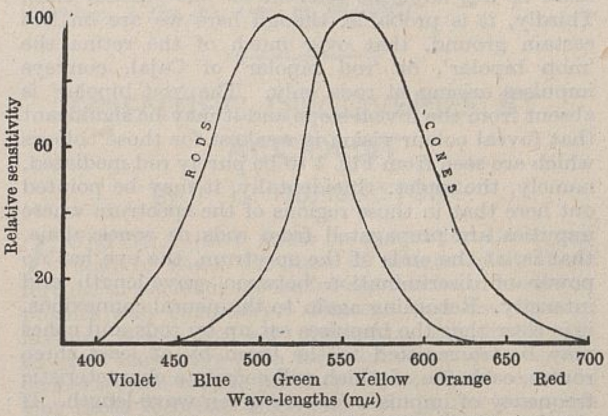

Fig. 1. SCOTOPIC AND PHOTOPIC VISIBILITY CURVES (EQUAL ENERGY SPECTRUM).

The functional sensitivity of the cones is probably closely represented by the photopic ocular visibility curve for the fovea obtained by Sloan[6]. Again, their actual sensitivity is seen in the photopic retinal visibility curve in terms of quanta recently obtained by Ludvigh[7]. The supposition that these curves represent cone activity receives direct support from Granit's observations in which the existence of a dominator is coincident with the presence of cones in the retina, and further support comes from the visibility curves for pure cone retinæ in which the maxima lie in the neighbourhood of 560 mμ. Recent determinations of this curve for the human eye by Ludvigh[7] show it to be remarkably symmetrical, a fact which he considers to favour the view that it represents either the absorption spectrum of a single substance or of a large number. He does not believe it to be consistent with the idea of three or four cone types such as would be required by the Young-Helmholtz theory in its popular form. Fig. 1, in which scotopic and photopic ocular visibility curves are plotted (equal energy spectrum), shows that the human retina in fact contains two elements which are differently sensitive to all regions of the spectrum and, if the rods are capable of functioning in daylight as well as in twilight, as we have seen to be possible, the retina thus contains the minimal necessary apparatus for discriminating between wave-length and intensity.

The visibility curves are essentially sensitivity curves. It is probable, however, that the responses given by the rods and cones are more or less directly related to the sensitivity of these elements and therefore we may properly consider the curves to some extent as response curves and think of the ordinates more in terms of impulse or discharge frequency, probably multiplied by some factor, than in terms of percentage of maximal sensitivity. It is therefore clear that for any wave-length there will be a characteristic ratio of impulses initiated from rods and cones and it will be well to consider the destination of these impulses. Unfortunately the neural connexions of the retina are extremely intricate, but in spite of this a few fairly definite conclusions may be drawn[8]. A great many of the cones, particularly in the regions of greatest colour sensitivity, are separately and individually connected with optic nerve fibres through midget bipolars and midget ganglion cells. It is almost equally certain that a great number of cones project their impulses together with those from more or less adjacent rods on to 'flat bipolar' cells. Thirdly, it is probable, though here we are on less certain ground, that over much of the retina the 'mop bipolar', or 'rod bipolar' of Cajal, conveys impulses arising in rods only. The 'rod bipolar' is absent from the foveal slope and it may be significant that foveal colour vision is weakest for those colours which are seen from Fig. 1 to be purely rod mediated, namely, the violet. Incidentally, it may be pointed out here that in those regions of the spectrum where impulses are propagated from rods or cones alone, that is, at the ends of the spectrum, the eye has no power of discrimination between wave-length and intensity. Returning again to the neural connexions, it is clear that the impulses set up by rods and cones may be transmitted to the brain by at least three routes, each one of which will convey a characteristic frequency of impulses for any given wave-length. If the intensity of the light be varied, the frequency along each route will vary coincidently so that the rod-cone response ratio for any wave-length will remain more or less the same. Much of the detailed analysis of the mechanism must depend upon the nature of this relationship between intensity and frequency of response. Owing to the present lack of direct information on this point the subject must remain one for conjecture and further experimentation. It may, however, be stated that the subjective changes in hue towards blue and orange seen upon increasing the intensity of violet and red light respectively are changes in the direction expected upon the hypothesis under discussion.

Much, of course, will also depend upon the nature of the interaction of the rods and cones when they are both projecting on to the same flat bipolar cell. Presumably there must be some form of summation or of inhibition. There is no direct evidence for either, and there is something to be said in favour of each. Antagonism or inhibition is suggested on grounds of comparative anatomy and physiology. For example, in those animals which have contractile bases (myoids) to both rods and cones, it has been observed that when the rod myoid contracts the cone myoid extends, and vice versa[9]. Inhibition also suggests itself as an explanation of the 'off effect' in electroretinograms. For example, when white light is acting on the retina the rods and cones may completely antagonize each other in their effects upon the flat bipolar cells except perhaps at the beginning ('on effect') and end ('off effect'), when their activities may not be completely synchronous owing to differences in reaction time. Moreover, there is the very interesting observation of Kravkov[10] that the sensitivity to certain colours may be changed, after some thirty minutes, by the application of a few drops of 1 per cent pilocarpine or of 1 : 1,000 adrenalin to the eye via the conjunctival sac. Adrenalin was found to increase the sensitivity to blue-green and reduce it to orange. It was found to have no effect on the colours at the ends of the spectrum, where rods and cones act independently, and there was a neutral or stable point in the yellow-green, strongly suggestive of the point of intersection of the rod and cone curves of Fig. 1. Precisely the reverse effects were obtained with pilocarpine. If this phenomenon be definitely shown to be retinal in origin, it would be explicable in terms of the balance of response set up by rods and cones, but it is difficult to incorporate into current theories.

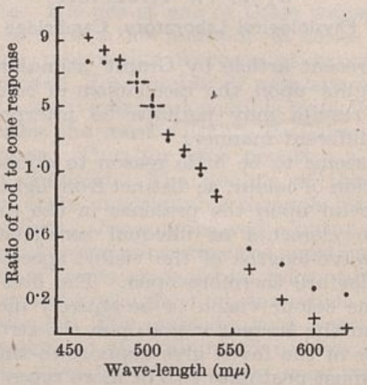

Fig. 2. ROD TO CONE RESPONSE RATIO OBSERVED (CROSSES) AND CALCULATED FROM COLOUR EQUATION (DOTS). WAVE-LENGTHS OF PRIMARIES 619, 540 AND 466 mμ.

The analyses of retinal activity recorded by Granit[1] are all based upon impulses picked up from optic nerve fibres and therefore are not necessarily recordings from the sensitive elements themselves but from retinal units. For example, it would be possible to interpret his dominator as the response of the cone unit and his modulators as the rod-cone units or rod units.

Any theory of colour vision must satisfactorily explain such things as saturation, hue discrimination, colour contrast, colour fields, colour mixture and complementary colours, colour blindness and so on. It is impossible within the limits of this article to show how each of these can be interpreted on the basis of rod and cone activity, but two or three particular points may briefly be discussed.

The equation $Q = aR + bG + cB$, expressing the relationship between the intensities (a, b and c) of the three primary colours (R, G and B) required to match any given colour (Q), can be modified by substitution for R, G and B the ratio of rod response to cone response, that is, R_1/C_1 for the red primary, R_2/C_2 for the green and R_3/C_3 for the blue. The three primaries are chosen so that $R_1+R_2+R_3=C_1+C_2+C_3$; that is, so that the total rod response is equal to the total cone response, which is the condition for the perception of white light so long as the total intensity is great enough. If this modification be carried out and the values of a, b and c for any given colour be read from the C.I.E. colour chart, the value of Q turns out to be the rod to cone ratio for the colour match. The extent of this agreement is indicated in Fig. 2, where the observed and calculated values for spectral colour matches are plotted together.

Consideration of Fig. 1 might suggest that any combination of rod and cone responses, and therefore any colour sensation, should be obtainable by suitably mixing an extreme violet, stimulating rods only, with an extreme red, stimulating cones only. The effects of raising the light intensities at these wave-lengths sufficiently to produce the necessary rod and cone responses have, however, to be considered. It is significant that the purples obtained by mixtures of red and violet can be converted into white by the addition of a suitable green.

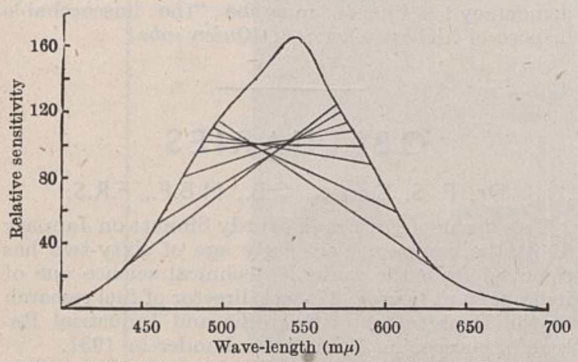

Fig. 3. SUMMATION OF SCOTOPIC AND PHOTOPIC CURVES; COMPLEMENTARY WAVE-LENGTHS CONNECTED BY STRAIGHT LINES.

A particularly interesting, though somewhat mysterious, confirmation of the hypothesis is obtained from a consideration of the effects of summating rod response and cone response. Physiologically, such summation might occur on the bipolar cells or on ganglion cells. The exact position of its occurrence is for the present irrelevant. When the scotopic and photopic visibility curves are summated, the curve shown in Fig. 3 is obtained, and it is clear from a study of this figure that such a curve has all the salient characteristics of the previously entirely empirical colour triangle. The lines joining points on the curve corresponding to complementary pairs all pass through nearly the same point; all wave-lengths shorter than 440 mμ or longer than 640 mμ are complementary to 570 and 496 mμ respectively, and greens can only have purples as complementaries. In this diagram the limits of the spectrum turn outwards, whereas in the colour triangle they are generally represented as turning inwards. The interpretation of this whole phenomenon is obscure, but its significance as a confirmation of the essential part played in colour vision by the facts described by the rod and cone sensitivity curves is manifest.

So far it has been tacitly assumed that, owing to the adaptation powers of the retina, rod and cone responses can be represented on the same scale, that is to say, the visibility curves can be directly compared in order to estimate the frequency of impulses travelling up the separate rod and cone fibres. This is the simplest assumption and may be used as a working hypothesis. It means that should, for any reason, the sensitivity of the rods with respect to the cones be increased or decreased, then some form of colour blindness would result. For example, many of the properties of the deuteranope would receive an explanation if his rods were relatively less sensitive than his cones. Similarly, the protanope would possess rods which were more sensitive than normal relative to the cones. Such quantitative variations in sensitivity of existing units would seem to be a more probable explanation of at least certain types of abnormalities of colour perception than the presence or absence of whole systems of hypothetical sensory units.

These selected points may be sufficient to indicate at least the possibility of interpreting colour phenomena in terms of the known activity of rods and cones. Naturally, there are difficulties, not the least of which is the structure and behaviour of the fovea, but these may perhaps yield to further investigation, and the hypothesis has the merits of not multiplying the sensory elements and of not invoking any structures which are not demonstrable.

[1] Granit, NATURE, **151**, 11 (1943).
[2] Studnitz, *Z. verg. Physiol.*, **28**, 153 (1940) (Abstract only).
[3] Hecht, *J. Opt. Soc. Amer.*, **20**, 231 (1930).
[4] Hecht and Williams, *J. Gen. Physiol.*, **5**, 1 (1923).
[5] Ludvigh, *Arch. Ophthal.*, **20**, 713 (1938).
[6] Sloan, *Psych. Mon.*, **38**, 1 (1928).
[7] Ludvigh, *Arch. Ophthal.*, **24**, 168 (1940).
[8] Polyak, "The Retina", Chicago (1941).
[9] Detwiler, *J. Opt. Soc. Amer.*, **30**, 42 (1940).
[10] Kravkov, *J. Opt. Soc. Amer.*, **31**, 335 (1941).

SCIENTIFIC DISCOVERIES BY ACCIDENT

By T. LL. HUMBERSTONE

FORTUNA favet fatuis is a familiar Latin tag. Mad or sane, the man of science must thank fortune or accident for useful discoveries in medicine, physics and chemistry. Pasteur said that chance favours those who are prepared. Accidental discoveries may have been forfeited owing to complete concentration on the primary object of the research. But those recorded are numerous. A few examples will demonstrate their value and variety.

Minkowski and von Mehring investigated the pancreas in relation to digestion. A laboratory attendant noticed that the urine of a dog deprived of its pancreas attracted swarms of flies. This was due to increased sugar content. The link between diabetes and the pancreas was established; the disease had been artificially induced and the way was open to Banting and Best for the discovery of insulin. Sir Lauder Brunton declared that his discovery of the effect of nitrites in dilating the arteries was accidental. For sufferers from that cruel disease *angina pectoris*, the drug acts like a charm. Diathermy and the induction of artificial fevers, new and important methods of treatment, were due to a feeling of discomfort noticed by one of Willis R. Whitney's assistants in attending to a high-frequency transmitter. Koch discovered how to separate microbes in a mixed culture through a half-potato left on his laboratory bench. By chance, two medical men discovered that mumps may cure whooping cough. Prof. Archibald Fleming's recent discovery of the bacillus-devouring power of *Penicillium notatum* was due to a chance observation.

In physics, chance discoveries have added to the wealth and happiness of mankind. A spectacle-maker of Middleburg who looked at a weathercock through two lenses was surprised to see an enlarged and inverted weathercock. The discovery was of value for war purposes. Galileo used the telescope to reveal the wonders of the heavens. He died in 1642, the year of the birth of Newton, exemplar of another method of scientific discovery, "travelling through strange seas of Thought, alone". Newton invented the reflecting telescope, the prototype of which is still in the proud possession of the Royal Society. The last—under construction in California—will in due course reveal new heavenly wonders. With apologies to Aristophanes, we may suggest that the frogs of Galvani are the most famous in the world. They hanged by a copper hook from an iron balcony. Galvani noticed that the dead frogs twitched when the wind brought their bodies into contact with the balcony. Thus the galvanic current was discovered, followed by the Voltaic pile, forerunner of the storage battery. Sir Richard Gregory in his book "Discovery" recalls that the Danish professor, Oersted, discovered induced currents by chance during a lecture experiment in 1819. Ampère, the French physicist, suggested that induced currents could be used for signalling at a distance, and two German men of science, Gauss and Weber, invented the first magneto-electric telegraph in 1833, a happy example of international co-operation in science. During Morse's experiments on telegraphy, a mile length of wire alongside a canal broke accidentally. Why not use the water of the canal ? Röntgen and Becquerel were favoured by chance in their important researches.

Iodine was accidentally discovered in 1811 by Courtois in the mother liquor of kelp. In those pre-Mendeléeff days, no chemist would deliberately set about its discovery. Colonel Silver records that ebonite was discovered by the accidental over-vulcanization of a rubber ball. The hypnotic property of sulphonal was discovered by chance. Antipyrine, an invaluable drug, was in a sense a chance discovery. The cyanide industry, of great value to Germany, resulted from the accidental discovery of Prussian blue by Diesbach early in the eighteenth century. That most useful gas, acetylene, was discovered by accident. The American, Willson, and the Frenchman, Moissan, re-discovered calcium carbide in 1892, working independently. Willson heated a mixture of coke and lime in an electric furnace in the hope of obtaining calcium. The resulting grey fusible mass was allowed to fall into a bucket of water and a copious supply of acetylene was produced. Chemists know of the result of a broken thermometer in relation to the oxidation of naphthalene and the synthetic indigo industry. Electro-plating benefited through a workman throwing his comrade's lump of cheese into a vat !

"Webster" defines chance as a supposed material or psychical agent or mode of activity other than force, law, or purpose. Force is as mysterious as space or time ; law in its scientific sense a somewhat fly-blown idol ; purpose in its teleological sense a vague aspiration. Chance relates to statistics, that queen of sciences, sadly contemned during the present War. We daily see provision made at great expense for war contingencies without regard to the principles of statistics and insurance. Nevertheless, physical science teaches that the most improbable events may happen. Stunned and stupefied by the wonders of modern science, the humble disciple is almost forced to the apostasy—*Credo quia impossibile est.* Was Newton a freak of Nature, due to some capricious combination of genes ? Will the world be reduced to chaos by fortuitous collisions of electrons thrown out of their orbits ?

Let us light a candle to the goddess of chance for boons received, for perils avoided !

Chance of chances, all is chance, says the Preacher. In a milligram of radium, about 500 million atoms disintegrate every second, each giving its characteristic radiation. How are these selected for destruction ? Not by seniority nor by lot like shipwrecked mariners on a raft, says Sir James Jeans in his new book, "Physics and Philosophy". Are we offered an escape from determinism, from "the forbidding materialism of the Victorian scientist" ? In the substratum below space and time, Jeans suggests, there may be springs of events including our own mental activities. The world made safe by democracy ! Chance may be "the unsearchable dispose of highest wisdom". *Quien sabe ?*

OBITUARIES

Dr. F. S. Sinnatt, C.B., M.B.E., F.R.S.

THE death of Dr. Frank Sturdy Sinnatt on January 27 at the comparatively early age of sixty-two has removed from the ranks of technical science one of its important figures. He was director of fuel research to the Department of Scientific and Industrial Research, succeeding Prof. C. H. Lander in 1931.

Born in Jersey in 1880, Sinnatt was educated in Manchester, graduating M.Sc.(Tech.) in chemistry from the College of Technology in 1901. He obtained his D.Sc. at Manchester in 1930 and was elected a fellow of the Royal Society in 1935.

Originally a lecturer in organic chemistry under Sir William Pope, Sinnatt became interested in coal at an early stage in his career, and from personal research extended his work on the subject by organizing lectures in fuel technology and interesting university students in this relatively new branch of science. Coal technology fascinated him and soon absorbed his entire scientific interest. His researches and lectures attracted the attention of the local coal owners, and in 1918 he organized with them the Lancashire and Cheshire Coal Research Association and eventually became its first director. In 1924 he was appointed by the Department of Scientific and Industrial Research as assistant director of fuel research and as superintendent of the Fuel Research Coal Survey. In 1931 he succeeded Lander as director.

Sinnatt's published papers go back so far as 1906. Two early researches (1923), which are still of academic and technical interest, are the carbonization of coal in the form of fine particles for the production of cenospheres, and the mechanism of the combustion of coal in the form of fine powder. In addition, his method for representing the structure of coal in coal seams is still in use. His papers on the examination of coal in the ground represent the first organized series to appear in Great Britain. His later publications are based mainly upon the work of the Fuel Research Station and the Fuel Research Coal Survey.

Sinnatt was thus not only one of the pioneers of survey work in coalfields, but also it is mainly due to his efforts that the National Survey of Coal Resources in Great Britain is so far in advance of coal surveys started in other countries. The records of the Survey have proved invaluable in war-time in defining the

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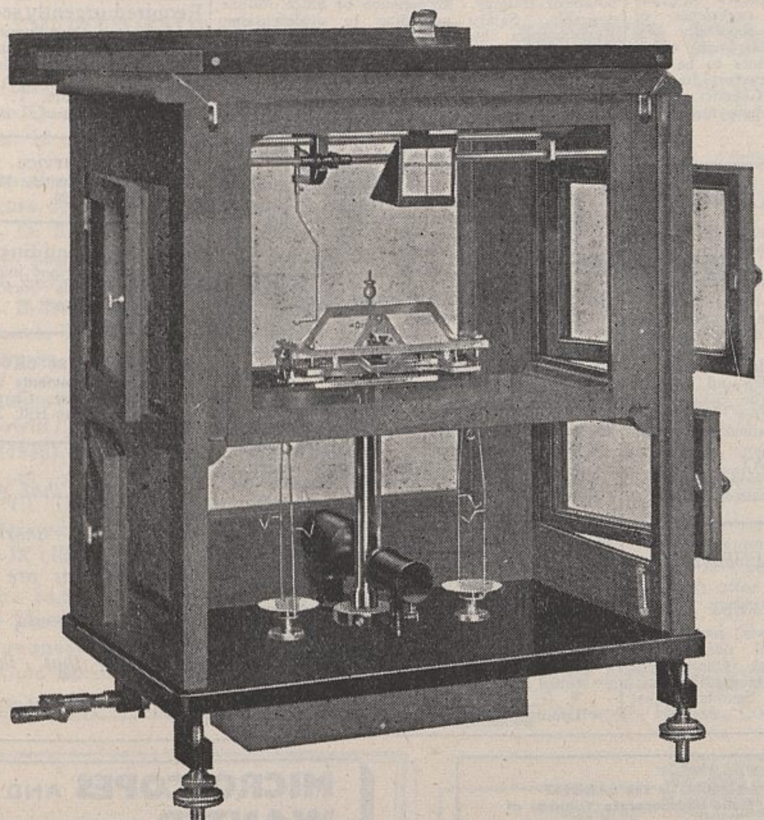

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properties of industrial coals and in serving as a basis for allocating these coals to their most appropriate industrial purposes. In general research work also Sinnatt's fertile imagination and infectious enthusiasms were an inspiration and example to his staff.

Sinnatt's interests, however, were not limited to his own organization, since he played an active part in the work of other scientific bodies. He served on the councils of the Institution of Mining Engineers, the Institute of Fuel, the British Colliery Owners' Research Association and the British Coal Utilisation Research Association, and he was a member of the British National Committee and Executive Committee of the World Power Conference. In addition, he was a member of the Iron and Steel Industrial Research Council and chairman of the Blast Furnace Scientific Panel. He was also an original member of the Coal Research Club, an informal group of coal technologists formed just after the War of 1914–18 to further coal research and with the special object of prediscussion of papers intended for publication. In forming this Club he was associated with other personalities well known in fuel technology such as Lessing, Stopes, Wheeler and Seyler. In all these wide activities Sinnatt's opinions and views were greatly appreciated.

Although in later years Sinnatt used up all his energies in the pursuit of science, he had had diverse interests in early life, of which the most important was military training. He joined the Territorial Army in 1908, went to France as a member of the Special Brigade, R.E., in 1915, and later, when forced on medical grounds to return to Great Britain, he assumed command of the University of Manchester O.T.C.

His enthusiasm and kindly personality will be sadly missed by the many people with whom he came into contact, and particularly by the staff of the Fuel Research Organization. J. G. KING.

Prof. Rudolph Abel

NEWS has reached Great Britain of the death on his seventy-fourth birthday of Rudolph Abel, professor of hygiene at the University of Jena. Born on December 21, 1868, in Frankfort-on-Oder, Rudolph Abel worked as assistant in Loeffler's laboratory at Greifswald, becoming *Privat-Dozent* in 1893, and afterwards in 1896 assistant at the Institute of Hygiene in Hamburg.

Abel devoted himself particularly to problems more directly concerned with hygiene, publishing many papers dealing with public health and the measures to be taken in combating such diseases as diphtheria and smallpox. He was drawn into the discussion that took place after the War of 1914–18 upon the effect which mass anti-typhoid inoculation of the male population had upon the relative incidence and mortality of typhoid in males and females in subsequent years. The rates for males were found to be very definitely lowered in comparison with those for females, and in this way a reliable indication of the lasting prophylactic effect of the war-time inoculation was obtained. He was consulted as an authority in the judicial trial which followed upon the tragic infections that occurred in Lübeck after the use of Calmette's B.C.G. vaccine.

As a *Privat-Dozent* at Greifswald under Loeffler, a chief whose name, with that of Klebs, will always be associated with the discovery of the diphtheria bacillus, Abel very naturally took a prominent part in the investigations of a number of problems concerned with the natural history and epidemiology of this important organism. The ground for further progress had been recently greatly cleared by Behring's discovery in 1890 of diphtheria antitoxin. Perhaps the most important discovery by Abel in this field was the demonstration in 1894 of the presence of diphtheria antitoxin in the blood of normal persons. This observation underlies much of the present-day practice of immunization against diphtheria. In the blood of diphtheria convalescents Abel found no antitoxin at the time of disappearance of the membrane, but some ten days later antitoxin appeared, only to vanish in the course of succeeding months. He made the suggestion, abundantly verified in recent years, that it is not the mere presence, but rather the amount, of diphtheria antitoxin in the blood that determines immunity.

To the carrier problem in diphtheria Abel made important contributions and also to the importance of fomites as potential sources of infection ; in 1893 he had isolated virulent diphtheria bacilli from a box of bricks 6½ months after a child suffering from diphtheria had played with them. Another problem that greatly interested Abel while in his twenties at Greifswald, and to which he devoted a series of bacteriological contributions, was the etiology of certain nasal conditions, in particular ozæna or atrophic rhinitis associated with the presence of organisms of the mucoid-encapsulated group, of which the prototype is Friedländer's bacillus. In his article on these organisms contributed to "Kolle and Wassermann", and to the third edition of this work edited by Kolle, Kraus and Uhlenhuth, he strongly maintained the view that from the very start of the condition of atrophic rhinitis with its accompanying ozæna, an organism found by him and known as the *Bacillus mucosus ozænæ* played a causative part. Writing in 1938, he had to admit that his view of the etiological role of 'Kapselbacillen' in the causation of the ozæna process had not gained the acceptance of rhinologists, and indeed the precise part played by this interesting group of organisms in disease has scarcely yet been adequately elucidated.

To the great compendium of current bacteriological knowledge already alluded to, Abel provided the first chapter, dealing with the historical development of our knowledge of infective immunity throughout the centuries to the time of Pasteur. It is a concise account and should be read in conjunction with the detailed and fully documented study of this theme by Bulloch in his "History of Bacteriology", published in 1938.

After some ten or twelve years of research on pressing bacteriological problems, Abel became more interested in those of general hygiene in its relationship to the State, and he wrote widely on a variety of public health questions. In so doing he departed to some extent from the Koch tradition, which made it almost imperative that holders of chairs of hygiene in German universities should be predominantly exponents and practising professors of bacteriology. For this reason and in view of the fact that his work on bacteriology occupied only his earlier years, Abel's achievements are probably less known to present-day bacteriologists than those of many of his contemporaries who have occupied chairs of hygiene in Germany since the beginning of the present century.

He will, however, be chiefly remembered in Great

Britain as the author of a very popular "Laboratory Handbook of Bacteriology", translated and published in 1907. In Germany, other text-books from the same pen served as practical guides to bacteriology and hygiene and ran into numerous editions.

Abel received the honorary title of *Geheimer Medizinalrat* in 1906 and was appointed to the chair of hygiene at Jena in 1915.

Lord Hirst

LORD HIRST's death on January 23 at the age of seventy-nine has caused poignant regret in many circles, for he was one who touched British social life at many different points. But his outstanding contribution to national life is in the industrial field. That he founded, and built up, the General Electric Company is well known. That he set a new standard in staff relationships in industry, which gave that Company a unique character, is less well known, and is a tribute to the unerring instinct he had for singling out the essentials in all matters which he handled. In this he showed a true scientific spirit by realizing that industry is run by human beings, and broadly its organizations must be made to suit human instincts and aspirations, and not the other way round.

As soon as Lord Hirst felt his Company was large enough to support a big research laboratory, he was able to fulfil a long-standing aspiration and established the Research Laboratories of the General Electric Company at Wembley. His instinct for essentials is again to be noted. His chief objective in founding these laboratories was not the expectation of startling the world with new inventions, welcome as such have been to him when they came. His first object was to provide a scientific general staff for his Company, complete with the facilities which a large laboratory could give them.

The services of this scientific staff were not to be forced on the factory managements. They were to operate at the intermediate levels of the Company, by working on factory problems with the engineering and process staffs in the works. Most of those who are experienced in industry will concur with Lord Hirst in emphasizing this essential place in manufacturing industry, where science should have its beginning and its primary focus.

As soon as it was clear, in 1939, that war was coming, Lord Hirst gave instructions that the research laboratories of his Company, with all their staff and facilities, should be put at the disposal of the Government without regard to commercial considerations. This offer was accepted in the letter and the spirit. The scientific assistance which his laboratories were thus enabled to bring to the war effort was a chief source of satisfaction to Lord Hirst in the closing years of a great life.

C. C. PATERSON.

NEWS and VIEWS

The Physical Society: Charles Chree and Duddell Medallists

THE Council of the Physical Society has awarded the Charles Chree Medal and Prize for 1943 to Prof. (now Colonel) B. F. J. Schonland and the Duddell Medal for 1942 to Dr. C. R. Burch. Col. Schonland, formerly professor of physics at Cape Town and afterwards director of the Bernard Price Institute of Geophysics at Johannesburg, is now in Great Britain doing scientific work in connexion with the War. Dr. Burch, formerly of the Research Department of the Metropolitan-Vickers Electrical Company, has continued his work in the Physics Laboratories of the Imperial College and the University of Bristol.

Prof. Schonland's work on atmospheric electricity has been primarily concerned with thunderstorm phenomena: first his investigations of the 'polarity' of thunderclouds in South Africa, and his measurement of the discharge from a small tree, which clearly established the importance of point discharges in maintaining the earth's negative charge; secondly, his systematic long-period observations on the interrelation of thunderstorms and penetrating radiation in the southern hemisphere; and thirdly, his use of a rotating-lens camera of the Boys type in a spectacularly successful series of systematic experiments which elucidated the rather complicated succession of discharges forming what is known as a 'stroke' of lightning.

As may be seen in some of the work of the two previous Duddell medallists—Lawrence's cyclotron and Coolidge's multi-sectional high-voltage X-ray tubes—one of the outstanding characteristics of modern physics is the large-scale application of vacuum technique. It is, primarily, in recognition of Dr. Burch's valuable contributions to the advancement of such technique that the present award of the Medal is made. His invention of the oil-diffusion pump, his still for the production of vacuum oils, greases and waxes, and his development of demountable vacuum-tight joints have made possible the attainment of high vacua on an engineering scale and thus greatly increased the range of experimental investigation. It was Burch's work on the production of flat surfaces for vacuum work that aroused his own interest in the grinding of optical surfaces and the possibilities of new developments in optical technique, on which he is now engaged. His remarkable versatility is seen also in his pioneer work in the invention (with Davis) of the induction furnace. In Dr. Burch we see a very rare combination: considerable mathematical ability, exceptional experimental skill, and ability not only to design his instruments but also to construct them in the workshop; in him Duddell would have recognized a kindred spirit.

The Nuffield Foundation

LORD NUFFIELD, to whom the world is already indebted for numerous benefactions, large and small, for the benefit of research particularly in social studies, has handed over his holdings in the Nuffield organization to the value of £10,000,000 as a capital fund which will be known as the Nuffield Trust. The fund will be administered by trustees, not exceeding seven in number, and the income will be devoted to (1) medical research and teaching; (2) organization and development of medical and health services;

(3) scientific research and teaching in the interests of trade and industry; (4) social studies; (5) care and comfort of aged persons. The normal scope of the Trust's activities will be Great Britain and Northern Ireland. Attention may, however, be given to projects particularly affecting the British Empire, and in regard to items 1 and 3 the provision of scholarships and other assistance for Empire students is included. Lord Nuffield's trusts which are already in being may benefit from the income of the new Trust.

The following have been appointed trustees to manage the new fund thus created: Sir William Goodenough (chairman), who is associated with other Nuffield Trusts; Sir John Stopford (vice-chairman), vice-chancellor and professor of experimental neurology in the University of Manchester; Prof. F. L. Engledow, Drapers' professor of agriculture in the University of Cambridge; the Hon. Geoffrey C. Gibbs; Sir Hector Hetherington, principal and vice-chancellor of the University of Glasgow; Sir Henry Tizard, president of Magdalen College, Oxford, and formerly rector of the Imperial College of Science and Technology; and Miss Janet Vaughan, who is a fellow of the Royal College of Physicians.

Science and Government

THE second annual luncheon of the Parliamentary and Scientific Committee, held on February 11, was attended by several members of both Houses of Parliament, including three Cabinet ministers, and by representatives of the associated scientific bodies. In an address on the organization of scientific effort in Great Britain, Sir John Anderson, Lord President of the Council, who has now become responsible for the Government's scientific services, recalled that Sir Stafford Cripps had already outlined the existing arrangements for scientific research and development in his address on January 30 before the conference on "Planning of Science: in War and in Peace" (see NATURE, February 6, p. 152). Sir John devoted himself therefore to the general principles which he believes should govern such arrangements. He believes that four main conditions must be satisfied: the organization must be an integral part of the Government machine; it should maintain contact with outside scientific bodies; it must not cut across normal ministerial responsibilities; and it must be linked up with a minister who is in a position to see that extra-departmental considerations are not neglected. The present organization of scientific effort, with the scientific advisers to the Ministry of Supply, the Scientific and Engineering Advisory Committees and so on, is, in Sir John Anderson's opinion, meeting these requirements tolerably well, and will provide a good basis on which to build up the type of organization required for the post-war world. Sir Robert Robinson spoke on the importance of the international control of explosives. As all the explosives in use by armed forces depend on the supply of nitrates, he urged the control of synthetic nitrate and similar plants as a measure for ensuring that aggressor nations shall not resort to war.

Parliamentary and Scientific Committee

ACCORDING to the annual report for 1942 of the Parliamentary and Scientific Committee, the membership now includes thirty-three organizations associated with scientific work and seventy-four members of the Houses of Parliament. During the past year, the main work of the Committee has been connected with the better utilization of scientific men in the war effort. A memorandum on the subject was prepared and a strong deputation saw Mr. R. A. Butler, then chairman of the Scientific Advisory Committee. Later, a motion urging the establishment of a Central Scientific and Technical Board was tabled in the House of Commons. This motion was allowed to lapse, after several questions designed to elucidate the position had been asked in the House, on the understanding that the functions of the scientific advisers to the Ministry of Supply would be widened as they became established. The Committee is watching the position. Discussions arranged during the year dealt with the dissemination of scientific knowledge among farmers (see NATURE, June 27, p. 722), the Industrial Health Research Board, the use of geology in war-time, pasteurization of milk and visual efficiency in factories. The secretaries of the Committee have continued to issue *Science in Parliament*, which summarizes important Parliamentary proceedings relating to science and technology. The following officers have been appointed for 1943: *President:* Lord Samuel; *New Vice-Presidents:* Captain L. F. Plugge, M.P., Prof. B. W. Holman, Mr. R. B. Pilcher (Institute of Chemistry); *Chairman:* Mr. E. W. Salt, M.P.; *Vice-Chairman:* Prof. J. A. Crowther (Institute of Physics); *Deputy Chairman:* Mr. M. P. Price, M.P.; *Hon. Treasurer:* Mr. C. S. Garland (Institution of Chemical Engineers); *Hon. Secretary:* Dr. W. R. Wooldridge (National Veterinary Medical Association).

Colonial Policy

A SOMEWHAT inconclusive debate on Colonial affairs took place in the House of Lords on February 9. The matter was raised by Lord Trenchard, who asked whether the Government could make any statement on methods of staffing and administering the Colonial Empire. Lord Trenchard referred to his previous inquiry on the subject last May, when he brought forward five matters for discussion: recruitment of the Colonial Civil Service, organization of a single interchangeable and independent Service, a Colonial Staff College, creation of a Colonial Advisory Board, and the possibility of grouping the Colonies into larger units. In the interval, other debates on the general subject have taken place, and in one of them Lord Listowel remarked that we now have an opportunity for atoning for past neglect of the Colonies. Lord Trenchard emphatically repudiated the suggestion that there has been neglect, showing that the British Colonial administration has brought peace and prosperity in its train; and he denied the suggestion that Great Britain has enriched herself at the expense of the Colonies. This point, it may be noted, was also made by Mr. R. G. Casey, now Minister of State in the Middle East, and a former member of the Australian Government, in a broadcast address delivered on February 14. Lord Listowel followed Lord Trenchard and discussed particularly the staffing and recruitment of the administrative services. He pointed out that high academic achievement is insufficient, and should be supplemented by special courses taken after having practical experience in the Colonies. Lord Elibank referred particularly to the difficulty of grouping Colonies. The importance of introducing local inhabitants into the administrative system was widely emphasized.

The Duke of Devonshire, Parliamentary Under-Secretary of State for the Colonies, replied to the debate. He said that the Colonial Office is not so academic as is often assumed; adding that he generally finds someone with first-hand and recent knowledge of any particular Colony at his immediate disposal. As regards suggestions for improvements in recruitment, they would be borne in mind; he pleaded that difficulty of war-time communication has made consultation slow and laborious. The Colonial Service consists of individuals employed under a variety of geographical conditions by a variety of Colonial Governments; European officers form only a small fraction of the whole. Hence re-organization of the Service is a matter, not for the Colonial Office alone, but for legislative bodies all over the world. Two main principles of development must be recognized; there must be partnership of the Colonial peoples in administration, but a substantial body of officers of European stock is still necessary to supplement local man-power. The formation some thirteen years ago of a series of unified professional services has provided a pool of highly qualified men who can be posted to any Colony and moved from one to another. Nevertheless he agreed that there should be nothing static in Colonial administration, and the whole position as regards this and other points raised is being examined in association with the Colonial Governments.

Packaging Research Committee

THE Printing and Allied Trades Research Association has set up a Packaging Research Committee to carry out investigations concerned with packages of which paper, board, film or foil form the main part. The research work will be carried out by the Association, which will set up a new department for the purpose, using its own laboratories or other research organizations as may be most appropriate. Preliminary consideration will be given to the systematic investigation of the elementary principles of the relation between the make-up of packages and their performance in use. The Association will also collect empirical data from individual firms in Great Britain and abroad with the view of obtaining a basis for long-range research. The outline programme already drawn up includes investigations on the penetration of various packaging materials by vapours, liquids, gases, heat and light, the effect of impregnation with various materials, damage by pests, design of packages, methods of sealing, and optimum use of automatic packaging machinery. Some ninety members of the industry have already applied for membership under the scheme. Communications should be addressed to the Director of Research, Printing and Allied Trades Research Association, 101 Princes Gardens, Acton, London, W.3.

Race Theories

ON February 8 a well-attended meeting of the Manchester University Branch of the Association of Scientific Workers heard a lecture on "Race Theories" by Prof. F. Wood Jones. The differences between various types of men are sufficient for them to be classified in three distinct species, the leiotrichi or mongol, the ulotrichi or negro, and the cymotrichi. The last-named species, to which we belong, is rather less easy to define. Since interbreeding between the species readily occurs, the view that there is only one species, *Homo sapiens*, has been widely held. Numerous zoological and botanical examples of the interbreeding of species with the production of fertile offspring are now known, and it is therefore again justifiable to speak of three distinct species, particularly as they can be distinguished in embryo less than three months old, as well as in fossil remains of the pleistocene period. Within these species are numerous sub-species or races, each with distinct characteristics. Segregation whether geographical, or religious and political as in the case of the Jews in Europe, tends to produce such races. Nevertheless in Europe at the present time there is no nation in which more than 10 per cent of the population belongs to a pure race. The belief that half-breeds of certain races inherit the worst qualities of both races is quite unfounded. The belief probably arose because in certain cases only the least desirable elements in both races produced such half-breeds. Professor Wood Jones strongly advocated intermarriage between all races.

Multi-part Domestic Electrical Tariffs

A PAPER under the title "Towards the 'Correct' Domestic Multi-Part Tariff" was read by P. Schiller before the Institution of Electrical Engineers in London on February 4. The author pointed out that the principle of multi-part costing and charging is again attaining particular importance in the intensive development of the domestic thermal load, which requires the unit charge component of multi-part tariffs to be reduced to the bare minimum. The necessary corollary of allocating to the standing-charge component the bulk of the actual standing costs involved in giving supply is impracticable with conventional two-part tariffs. At present the standing charge covers little more than the standing costs due to the demand for lighting and small domestic appliances, which is but a small fraction of the total demand of modern domestic installations. Hence the bulk of the standing costs due to the domestic thermal load must be averaged out on the unit-charge component.

A 'correct' domestic multi-part tariff must take account of the individual consumer's demand, and this becomes more and more justifiable as inter-consumer diversity grows poorer in consequence of the predominance of the space-heating load. Owing to the rigid character of lighting and cooking demands, it appears to be sufficient to consider the individual consumer's demand only in connexion with the elastic requirements of water-heating and space-heating. Tariff charges based on actual demand can be put into effect by either recording or limiting consumers' maximum demands during periods of heavy load on the general supply system. As to the second alternative, the 'contract-demand' method can be developed to such an extent as to be capable of everything the maximum demand indicator method achieves, while obviating the drawbacks of the latter. Thus a 'correct' domestic multi-part tariff may be found in a revival and modernization of the contract-demand method. Whether such a tariff is also an ideal one is open to discussion. But the principle of charging domestic supplies on the basis of both consumption and demand is worth reconsidering at all events.

Boiler-House Measurements and Control

A PAPER by G. H. Barker and A. L. Hancock, read before the Institution of Electrical Engineers in London recently, on boiler-house measurements with special reference to the efficient utilization of fuel, reviews the development of boiler-plant instrumentation from the early use of measuring instruments as mere safety devices to the modern employment of remote centralized control, based upon the comprehensive measurement of the operating conditions. As improvements in plant design and operating efficiency are governed by the degree to which their dependent factors are known and understood, exploratory measurement must embrace all the measurable quantities, while the operating measurements must include those of all the variables which are susceptible to regulation. A table of essential measuring instruments for shell-type and water-tube type boilers is included in the paper. Remote manual control is compared with automatic control in order to show that, as measurement is now the acknowledged basis for control, it follows that the measuring instruments which detect and report the adverse tendencies should be used to institute the corrections needed to arrest them, wherever this is practicable.

Standards of Electrical Measurement

DR. L. HARTSHORN has written an interesting progress review on this subject (*J. Inst. Elect. Eng.*, 89, Pt. 1, No. 24 ; Dec. 1942). Following introductory paragraphs dealing with the general character of measurement, an account is given of the more recent experimental researches of the standardizing laboratories, and of the present legal and international position of the various electrical units. The review is presented under the headings of units and standards, fundamental and derived measurements, the absolute system and the international position. The section on the absolute system deals with the measurement of inductance, current, resistance and voltage, capacitance and quantity of electricity, power and energy, practical standards, and frequency. The remarks relating to the international position give prominence to the M.K.S. system.

Maternal and Child Welfare in Venezuela

DISCUSSING maternal and child welfare in Venezuela (*Bol. Of. San. Panamericana*, November 1942) Dr. Pastor Oropeza refers to the creation in 1936 of the Ministry of Public Health and Social Welfare as providing a sound foundation. At the present time, these services are under the direction of the Division of Maternal and Child Hygiene. The Ministry operates through health units and health centres, and offices in places where centralized local public health services have not been organized. In 1942 there were 37 fully qualified health units, 4 health offices and 61 rural medical officers. Regulations have been issued for the supervision and education of midwives. In 1936, pregnancy was made the subject of industrial legislation. Obstetrical assistance and post-natal care are given to the wives of insured workers. The official infant death-rate has fallen in Venezuela from 124 per 1,000 live births in 1936 to 121 in 1940, but these figures are probably inaccurate owing to many births not having been registered until baptism, and numerous deaths were probably not reported. Child welfare work includes examinations and immunizations carried out by the various health centres, assisted by public health measures. During 1930–41, 45 stations for distribution of milk to children were organized throughout the country in connexion with health centres. Attention is also given to the care of sick children mainly through the welfare agencies of the States and municipalities. Other developments include the creation of a course in clinical pædiatrics and puericulture, and a new law making these subjects compulsory for medical qualification.

Commemoration of Copernicus in the United States

THE Kosciuszko Foundation of New York is making arrangements to celebrate the four hundredth anniversary of the death of Copernicus on May 24. Invitations to take part have been sent to American universities and other institutions by Dr. Henry N. MacCracken, president of Vassar College and also of the Kosciuszko Foundation. With Poland now associated with the United States in the war of survival and several million citizens of Polish extraction living in the United States, it is the desire of the Foundation to make the occasion an outstanding event in the history of science.

Announcements

THE Committee of the Athenæum has elected the following under the provisions of Rule II of the club, which empowers the annual election by the committee of a certain number of persons of distinguished eminence in science, literature, or the arts, or for their public services : Sir William Stanier, scientific adviser to the Minister of Production ; Sir Thomas Lewis, director of clinical research, University College Hospital ; Sir Bernard Pares, lately professor of Russian history, University of London.

THE Managers of the Royal Institution have awarded the Actonian Prize of one hundred guineas for the year 1942 to Dr. Alexander W. G. Ewing and Mrs. Ewing for their investigation concerning the detection, measurement and assessment of deafness, their pioneer work upon hearing aids, and the development of their successful technique for education by the 'hearing lip reading' method.

DR. ROBERT E. WILSON, president of the Pan American Petroleum and Transport Company, has been awarded the Perkin Medal of the American Section of the Society of Chemical Industry for outstanding work in applied chemistry. His work includes research on such varied subjects as flow of fluids, corrosion, motor fuel volatility and contributions in the use of tetraethyl lead.

THE Institute of Industrial Administration is organizing a Conference on Training for Industrial Management, to be held at the Waldorf Hotel, London, during March 5–7. The opening session on March 6, on "Management and Nation", will be addressed by the Archbishop of Canterbury. Other sessions will be devoted to the position of management in industry, external and internal training for industry, and the training required by a director. Particulars can be obtained from the Institute, Artillery House, Artillery Row, London, S.W.1.

THE Council of the Harveian Society of London announces that the subject of the Buckston Browne prize essay for 1943–44 will be the use and abuse of sulphonamides. The essay must be sent to the Treasurer of the Society, 14, Devonshire Street, W.1, by October 1, 1944.

THE German Academy of Natural Science at Halle proposes to issue an edition of Goethe's scientific works.

LETTERS TO THE EDITORS

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

Stability of Ascorbic Acid in Metaphosphoric Acid Extracts

IT is frequently impossible to perform an analysis of ascorbic acid in foods immediately after sampling. In some cases a delay of as long as 24 hours is unavoidable, and doubts have arisen as to the reliability of the results then obtained. Most analysts now employ metaphosphoric acid or a mixture of metaphosphoric and trichloroacetic acids as the extractant, when determining ascorbic acid by titration against 2,6-dichlorophenolindophenol. We have accordingly investigated the rate of oxidation of ascorbic acid in 5 per cent metaphosphoric acid solution and in a mixture containing 2 per cent metaphosphoric acid and 5 per cent trichloroacetic acids. The solutions were pure ascorbic acid and extracts of cabbage, potato and swede.

Ascorbic acid suffers photochemical decomposition if exposed to light, when present either in pure solutions or in foods such as milk[1,2,3]. Kellie and Zilva[4] found that the destructive influence of light was less at pH 3·0 than at alkaline reactions. We have found that even in very acid solutions (5 or even 20 per cent metaphosphoric acid), ascorbic acid is not stable unless the solutions are kept in the dark.

Fig. 1 shows that, in the dark, pure ascorbic acid was stable in 5 per cent metaphosphoric acid solution for at least 2 days at a temperature of 20° C., whereas if kept in daylight 50 per cent of the ascorbic acid was oxidized within 53 hours. When the solution was kept at 0° C., in the dark, there was no deterioration over a period of six days. Irradiation of the solution with ultra-violet light had an even greater destructive effect than daylight.

Ascorbic acid in extracts of various vegetables was less stable, whether in the light or in the dark, than were solutions of the pure acid. Thus ascorbic acid in a cabbage extract in a mixture of 2 per cent metaphosphoric and 5 per cent trichloroacetic acid was stable for two days when kept in the dark at 20° C. (Curve 1, Fig. 2), after which oxidation proceeded at an increasing rate until at the end of ten days 50 per cent of the ascorbic acid had disappeared. In swede

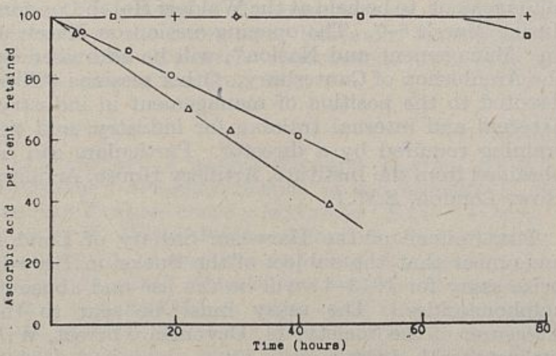

Fig. 1. STABILITY OF SOLUTION OF PURE ASCORBIC ACID IN 5 PER CENT METAPHOSPHORIC ACID.

△——△ Solution irradiated with ultra-violet light at 20° C.; ○——○ Solution kept in daylight at 20° C.; □——□ Solution kept in dark at 20° C.; +——+ Solution kept in dark at 0° C.

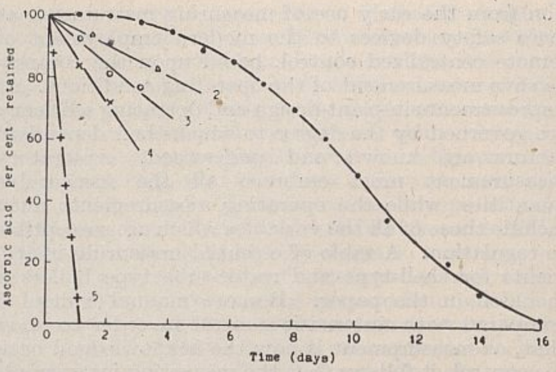

Fig. 2. STABILITY OF ASCORBIC ACID IN METAPHOSPHORIC AND TRICHLOROACETIC ACID EXTRACTS OF CABBAGE, POTATO AND SWEDE.

Solution 1. Cabbage extract: 2 per cent metaphosphoric and 5 per cent trichloroacetic acid.
Solution 2. Swede extract: 5 per cent metaphosphoric acid.
Solution 3. Cabbage or potato extracts in contact with deposit: 2 per cent metaphosphoric and 5 per cent trichloroacetic acid.
Solution 4. Cabbage or potato extracts in contact with deposit: 5 per cent metaphosphoric acid.
(Solutions 1–4: Solution kept in the dark at 20°.)

Solution 5. Cabbage extract: 2 per cent metaphosphoric and 5 per cent trichloroacetic acid. Swede extract: 5 per cent metaphosphoric acid.
(Solution kept in daylight at 20°)

extract made with 5 per cent metaphosphoric acid (Curve 2, Fig. 2) the oxidation was a little more rapid, but after twenty-four hours 95 per cent of the ascorbic acid remained in the reduced form. The stability of ascorbic acid in both cabbage and swede extract was increased if the extracts were kept at 0° C. in the dark; 5 per cent metaphosphoric acid extracts of cabbage or swede have both been kept for more than sixty hours without loss.

When the centrifuged deposit was left in contact with the supernatant acid extract, the ascorbic acid was oxidized somewhat more rapidly. Curves 3 and 4 show the rate of oxidation in the metaphosphoric - trichloroacetic acid mixture, and in 5 per cent metaphosphoric acid respectively at 20° C. Curves 3 and 4 have been constructed from analyses of samples of cabbage or potato which were estimated at once and after one, two and three days, and each point is the mean of the results obtained from a considerable number of samples. After twenty-four hours in the dark at 20° C., 91 per cent of the initial ascorbic acid remained in the metaphosphoric - trichloroacetic acid mixture, while in the 5 per cent metaphosphoric acid mixture the residual ascorbic acid was 85 per cent of the original amount. When kept in daylight, the rate of oxidation in these food extracts was increased to such a degree that 50 per cent of the ascorbic acid was destroyed within twelve hours (Curve 5, Fig. 2).

Comparison of these results with those in Fig. 1 shows that the rate of oxidation of ascorbic acid in metaphosphoric acid extracts of foods in daylight at 20° C. is some two to three times greater than that of the pure substance. This is not surprising in view of the presence in foods of substances such as copper, iron and riboflavin, which catalyse the oxidation of ascorbic acid.

Conclusion. Samples taken for analysis for ascorbic acid in 5 per cent metaphosphoric acid or a mixture of metaphosphoric and trichloroacetic acids should be kept in the dark if any delay between extraction and analysis is likely to occur. If the extracts are kept at 0° C. there should be no loss over a period of two days; if kept at room temperature analysis should be completed within twenty-four hours. Loss is less when the supernatant extract is separated from the precipitate.

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[1] Kon, S. K., *Biochem. J.*, **30**, 2273 (1936).
[2] Schroeder, H., *Münch. med. Wschr.*, **84**, 1942 (1937).
[3] Scheer, K., *Münch. med. Wschr.*, **86**, 603 (1939).
[4] Kellie, A. E., and Zilva, S. S., *Biochem. J.*, **32**, 1561 (1938).

Automatic Separation of Wet from Dry Grain for Storage

WHEN wheat is too damp for prolonged storing, which is usually true of the home-grown crop in Great Britain, deterioration, accompanied by heating and development of fungi, is commonly observed to occur first in small patches buried in the bulk. These are the wetter portions of the bulk. If all the grain is very damp, heating may spread from these foci throughout the bulk; but even if this does not happen, development of fungi in such small areas may produce sufficient taint throughout the bulk to make the grain unfit for milling. This experience, common in the storage of English grain, has been confirmed in America by Kelly and others[1] by extended storage tests. Consequently, in so far as it is affected by water-content, the storage life of a bulk of grain depends on the maximum water-content at any point, rather than on the mean water-content of the bulk. Hence, for any mean water-content, the maximum storage life is reached when variations from the mean are reduced to a minimum. Such variations are greatest in grain harvested by combine, often because of irregularities in ripening in the field; but non-uniformity of water-content causes difficulty in storage of grain in Great Britain whatever method of harvesting is used. The variations might be brought to a minimum by thoroughly mixing every load of grain, but this is impossible without large-scale machinery, and even the handling plant of a large modern silo is barely adequate for the purpose. Consequently, it is seldom certain that grain in bulk is of uniform water-content. Nevertheless, mixing and thorough drying of the entire crop are the only methods at present available to ensure that English wheat shall have an adequate storage life. Increasing production is putting an extreme strain on drying facilities; therefore, an alternative to drying the whole crop is desirable.

The development of rapid electrical methods for the determination of water-content of grain has made it possible to design a machine to separate the wetter portions of a grain stream. This process will eliminate wide water-content variations while lowering the mean water-content of the bulk. After this separation the drier fraction (which may be a large proportion of the whole) will have a longer storage life than would be expected of a normal, more heterogeneous, bulk of the same mean water-content. The small wetter fraction may easily be given priority for drying. Because of its high water-content a greater amount of water will be removed by a given quantity of heat, or by a particular size of drier, than if the original bulk had been dried before separation.

The variations in water-content in a single freshly threshed bulk are so wide that a separator which would be capable of reducing this wide range very greatly need not act with great precision. Accordingly a simple physical measurement may be made the basis of operation. In this laboratory a machine has been constructed in which grain passes in a stream of constant thickness between two metal plates acting as a condenser. The current passed to earth by this condenser, when an alternating potential of constant frequency is applied to one plate, controls the separating mechanism. This consists of a hinged metal plate which diverts the stream of grain to either of two chutes according to the current passing through a spring-loaded adjustable relay. It has been found satisfactory to convey the grain stream between the condenser plates on a moving cotton band, but some mechanical disadvantages of this arrangement are overcome if the surface of a revolving cylinder is substituted for a moving band. A machine of this type, large enough to deal with grain in commercial quantities, is now under construction in this laboratory.

The total current passed by a condenser under the conditions described is partly capacitative and partly resistive, the proportions of each varying with the water-content of the grain between the plates. It cannot, therefore, be claimed that the condenser current measures with precision the water-content of the grain stream, but the precision obtainable is adequate for the purpose. If, for other purposes, a separator working at a more precisely defined water-content were required, a circuit of one of the types developed by Dr. Hartshorn, of the National Physical Laboratory, would be very suitable.

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[1] Kelly, C. F., Stahl, B. M., Salmon, S. C., and Black, R. H., "Wheat Storage in Experimental Farm-Type Bins", U.S.D.A. Circular No. 637, April 1942.

'Pasmo' Disease of Flax

DURING the summer of 1942 a culture of a fungus was received from Dr. R. M. Nattrass, of Kenya, who stated that the organism had been isolated from flax plants suspected of being affected with 'Pasmo' disease and that he believed it to be *Sphærella linorum* (Naoum.) Wr., the cause of the disease.

Examination of the fungus showed that its characters were in close agreement with those recorded for *S. linorum*. To investigate its pathogenicity, flax plants which were at the flowering stage were sprayed with a suspension of spores prepared from a single-spore culture. They were then covered with bell jars for four days. Lesions, identical with those described for 'Pasmo' disease, appeared on the plants some fourteen days after inoculation. The organism was re-isolated from pycnidia produced on these lesions and re-inoculated into healthy plants. Positive results were again obtained and the organism again re-isolated. Control plants sprayed with water at the same times remained healthy. Inoculation experiments were made both under glasshouse and open-air conditions and, in each case, infection resulted. Special precautions were taken to isolate the plants used in these trials, and they were destroyed immediately after the work had been concluded.

Lesions were produced on both leaves and stems, mainly on the upper portions of the plants. They were brown in colour and at first small, somewhat elongated, and extended only part of the way round the stem. Later, they increased in size and ultimately encircled the stem; it was common to find diseased and healthy portions of the same stem occurring alternately. As the result of encirclement, the portion of the plant above the lesion was frequently killed and this 'strangling' effect is aptly described by the common name given to the disease. Illustrations of typically infected stems, including an example showing how the top of the plant may be killed, are seen in Fig. 1. Fig. 2 is a photograph of a typical lesion showing the presence of pycnidia. In some cases the stem lesions are not unlike those produced by an attack of browning (*Polyspora Lini* Laff.), but the production of pycnidia in the case of 'Pasmo' attack is a clear and reliable distinguishing characteristic. The minute cream-coloured acervuli produced by *P. Lini* are not commonly found in the field but develop readily on the incubation of infected stems. Fig. 3 shows a typical browning lesion, while Fig. 4 shows such a lesion after incubation when acervuli have been produced in abundance.

'Pasmo' disease was first described by Spegazzini[1] in the Argentine; he named the causal organism *Phlyctœna linicoli*. Garassini[2], also working in the Argentine, renamed it *Septoria linorum*.

The disease is known to occur in the Argentine (Spegazzini[1]); United States of America (Brentzel[3,4]); Canada (Henry[5]); New Zealand (Cunningham[6]); Siberia (Natalyina[7]); Yugoslavia (Rost[8]); Rumania (Rost[9]); Germany (Wollenweber and Krüger[10,11]); Hungary (Kremmer[12]); and Peru

Fig. 1.

Figs. 2 3 4

(Rome[13]). It has not been recorded for the British Isles.

Brentzel[14], who has studied the disease in the United States in considerable detail, states that pycnospores may accumulate on diseased stems and stubble, from which infection originates in the following spring. He also states that the disease is transmitted by the seed.

No evidence has yet been produced to show that 'Pasmo' can be successfully controlled by seed disinfection. Various workers have studied the resistance and susceptibility of flax varieties to attack but little information is available regarding the behaviour of those fibre varieties commonly grown in the United Kingdom. As the disease has not yet appeared in the British Isles, every effort should be made to prevent its occurrence, and the greatest care should be taken to ensure that flax seed imported into the United Kingdom is free from contamination with *S. linorum*.

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ARTHUR E. MUSKETT.

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Plant Disease Division,
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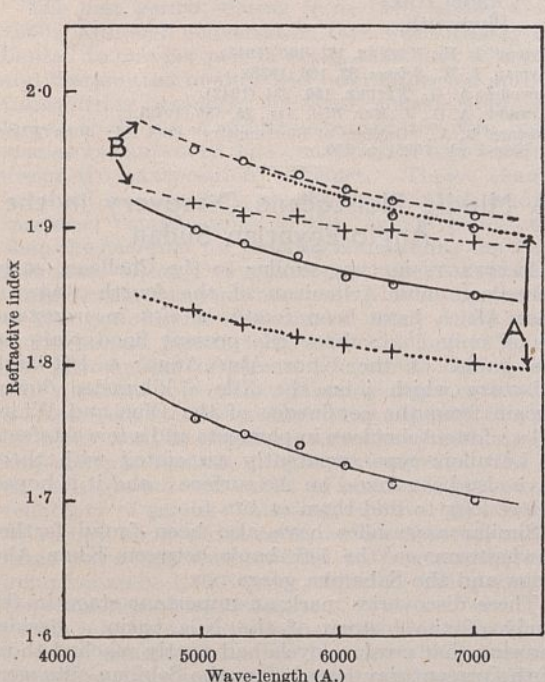
Belfast. Jan. 20.

[1] Spegazzini, C., *An. Mus. Nac. Buenos Aires* (III), **13**, 389–390 (1911).
[2] Garassini, L. A., *Rev. Fac. Agron. La Plata*, **20**, 170–261 (1935); Abs. in *Rev. Appl. Mycol.*, **15**, 441.
[3] Brentzel, W. E., *Phytopath.*, **13**, 53–54 (1923).
[4] Brentzel, W. E., *Phytopath.*, **14**, 48–49 (1924).
[5] Henry, A. W., *Alberta Agric. Coll. Bull.*, **18** (1928); Abs. in *Rev. Appl. Mycol.*, **8**, 371.
[6] Cunningham, G. H., *N.Z. J. Agric.*, **42**, 305–306 (1931).
[7] Natalyina, O., *Plant Protection, Leningrad*, **8**, 177–183 (1931); Abs. in *Rev. Appl. Mycol.*, **11**, 45-46.
[8] Rost, H., *Angew. Bot.*, **19**, 163–171 (1937); Abs. in *Rev. Appl. Mycol.*, **16**, 676.
[9] Rost, H., *Angew. Bot.*, **20**, 412–430 (1938); Abs. in *Rev. Appl. Mycol.*, **18**, 315–316.
[10] Wollenweber, H. W., *Rev. Bot. Inst. "Miguel Lillo"*, **2**, 483–494, (1938); Abs. in *Rev. Appl. Mycol.*, **18**, 111–112; Wollenweber, H. W., and Krüger, E., *NachrBl. dtsch. PflSch-Dienst.*, **18**, 11–12 (1938); Abs. in *Rev. Appl. Mycol.*, **17**, 458–459.
[11] Krüger, E., *Arb. biol. Reichsanst. Brl.*, **23**, 163–188 (1941).
[12] Kremmer, J. A., *Bot. Köl.*, **38**, 62-67 (1941): Abs. in *Rev. Appl. Mycol.*, **20**, 494.
[13] Rome, *Int. Bull. Pl. Prot.*, **16**, 4M (1942); Abs. in *Rev. Appl. Mycol.*, **21**, 352.
[14] Brentzel, W. E., *J. Agric. Res.*, **32**, 25-37 (1926).

Optical Dispersion for Coals

USING the apparatus previously described[1], together with a set of Wratten Monochromat light filters Nos. 70–75, it has been possible to examine the variations of refractive index over a limited range of wave-lengths in the visible spectrum for several typical coals of varying rank. The Brewster angle was determined with each filter placed in turn before the light source, and the corresponding refractive index calculated. The determining factor limiting the accuracy of the measurements was the stability of the photo-cell amplifier. Under the most unfavourable conditions the limits of accuracy of the determination of refractive index were $\pm 0 \cdot 01$. In general, the accuracy was greater than this.



—o—, perpendicular to bedding plane
—+—, parallel " " "

Typical results are given in the accompanying figure. For two isotropic coals, the lower full-line curve is for a free-burning coal and the upper for a coking coal. For the anisotropic coals measurements were made in directions perpendicular (rings) and parallel (crosses) to the bedding plane. The curves *A* are for a Welsh anthracite and the curves *B* for a Welsh steam coal.

For all the measurements made in a direction perpendicular to the bedding plane the dispersion curves are approximately parallel; the curves for the measurements made parallel to the bedding plane are themselves parallel. But the slopes of the two sets of curves, shown respectively with rings and crosses, are markedly different. From these results it would appear that the refracting material varies but little with the rank of the coal. The difference shown in the two directions would, however, be consistent with a large-scale structure in which anisotropic units occur with preferred orientation. On such a supposition the isotropy of the lower rank coals could be obtained by completely random orientation of the same anisotropic units.

Thanks are due to Mr. J. G. Bennett, director, and Dr. D. H. Bangham, principal scientific officer, of the British Coal Utilization Research Association, for their kindness in providing the specimens.

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[1] NATURE, **150**, 690 (1942); and **151**, 53 (1943).

Nature of Entropy

THE opening paragraph of Mr. Ian Campbell's letter[1] on the nature of entropy reads somewhat strangely to one fresh from the perusal of "Physics and Philosophy" by Sir James Jeans. Campbell argues that "a quantity which fits so completely into the mathematics of the subject must surely have some relation to the physical facts", and suggests that entropy may be regarded as analogous to momentum in mechanics. Jeans asks whether we should adopt mechanical *explanations* of Nature or the mathematical *description* of Nature, and concludes: "whether the ghostly remains of matter should be labelled as matter or as something else is mainly a question of terminology" (p. 216).

From the educational point of view, however, it is in my opinion necessary that the beginner in a scientific subject should be given at the outset some familiar mental picture. Some physical analogies of the "ghostly" quantity entropy have been described in a recent text-book[2], and it may be pointed out that before the end of last century it was customary in the Royal Naval Engineering College, Devonport, to regard entropy as 'thermal inertia', and to use rotational motion especially to illustrate thermodynamic principles, treating entropy as 'rotational inertia' (moment of inertia)[3]. In his presidential address to the Physical Society in 1911, Prof. H. L. Callendar stressed the correspondence between entropy and 'caloric'. On this view, we may regard Joseph Black's 'matter of heat' as equivalent to a mathematical function, or alternatively we are in some measure entitled to regard entropy as the modern expression for caloric.

In order to support his view as to the nature of entropy, Campbell proposes the adoption of a new scale of temperature so that "temperature may become proportional to the square root of heat energy and, in the kinetic theory, to the mean molecular velocity". I am not at all clear as to his attitude to Lord Kelvin's absolute scale of temperature—one sentence in his letter asserts, or at least suggests, that temperature "cannot be measured absolutely". On this subject there is a recent article[4] on a dynamical treatment of the elements of heat by Dr. G. Burniston Brown, in which an elementary and more directly empirical discussion is given in a form suitable for beginners. In this connexion it is worth while directing attention to the fact that momentum, depending on the first power of the velocity, is a vector quantity, having direction and sense as well as magnitude. This in itself indicates that momentum is not likely to be a suitable analogy for entropy. It should be noted that in the elementary development of Boyle's law on the basis of the kinetic theory of gases, the *square* of the velocity is involved because not only momentum enters but also the time taken by a molecule in travelling across the cubical enclosure.

The argument drawn by Campbell in favour of his suggestion from the expression $\frac{1}{2}CV^2$ for electrical energy is not convincing, and is possibly misleading. The more fundamental formula is $\frac{1}{2}QV$, where Q is quantity of electricity and V is potential. This form suggests that Callendar was right in linking entropy to "matter of heat" as the equivalent of Q, while V corresponds to temperature.

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University,
St. Andrews.
Feb. 3.

[1] Campbell, Ian D., NATURE, 151, 138 (1943).
[2] Allen and Maxwell, "Text-Book of Heat", Part 2, Chap. 30 (Macmillan, 1939). Reference may also be made to Part 1, Chap. 23, dealing with "Physical Magnitudes and their Measurement".
[3] Wheeler, S. G., "Entropy as a Tangible Conception" (Crosby Lockwood, 1921). Allen, H. S., NATURE, 109, 404 (1922).
[4] Brown, G. B., *Phil. Mag.*, 33, 543 (1942).

Newt Larvæ in Brackish Water

THE statement in Miss H. Spurway's interesting observations on the above subject[1], that it is generally believed that amphibian larvæ are not found in salt or brackish water, is interesting because the brackish 'slacks' or pools between the west Lancashire coastal dunes from Ainsdale to Formby have long been inhabited by breeding specimens of the common smooth newt, common frog, common toad, and natterjack toad. The natterjack is, of course, a well-known breeding inhabitant of brackish estuary waters; many hundreds breed at Ainsdale; and I have seen its tadpoles in the tide line salt marsh at the Dee mouth between Hilbre Point and Hoylake, Cheshire, and at other estuaries.

Incidentally, mention of the natterjack toad reminds me that a species inhabits Gilbert White's famous great pond at Wolmer, although not numerously, but he did not list it in his time.

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Liverpool, 15. Jan. 28.

[1] NATURE, 151, 109 (1943).

Water Content of Medusæ

I HAVE read with considerable interest the recent communication from Dr. L. H. Hyman dealing with the water content of medusæ[1]. My apologies are due to Dr. Hyman for having failed to refer to his communication of 1938[2] in my own contribution to NATURE[3]; but when I was doing the work and also when writing up the account it was impossible for me to get hold of the proper references, since the greater part of the library has been removed from the Laboratory at Plymouth. However, the omission shows the close agreement in our independent results.

I do not propose to discuss the merits of our different methods beyond stating that, in the *displacement method*[4], the living specimens of *Aurelia aurita* were neither rinsed in distilled water nor drained, since in this method the living specimens are not removed from their environment. According to Dr. Hyman the water content of *Aurelia aurita* in sea-water of 3·2 per cent salinity was 96 per cent, while I found it to be 96·56 per cent in sea-water of the same salinity.

Reference to the figures given by Dr. Hyman in 1938[2] will show how close the agreement is between the determinations made on both sides of the Atlantic, and one trusts that the figure 99·8 per cent for the water content as originally recorded by Gortner[5] can now be allowed to sink into obscurity and no longer find its way into current text-books either of an advanced or elementary nature. One would expect the water content to vary slightly in different specimens, but its value lies between 96 and 96·6 per cent, and it varies slightly with the salinity.

Further, in medusæ living in water of more than 3 per cent salinity, the water content ranges from 94 to 96·6 per cent. In freshwater medusæ it may be higher. 99·8 per cent is clearly an impossible figure for the water content of any animal living in ordinary sea-water, though admittedly such an animal might be composed of 99·8 per cent *sea-water*.

A. G. LOWNDES.
The Laboratory,
Citadel Hill,
Plymouth.

[1] Hyman, L. H., NATURE, 151, 140 (1943).
[2] Hyman, L. H., *Science*, 87, 166 (1938).
[3] Lowndes, A. G., NATURE, 150, 234 (1942).
[4] Lowndes, A. G., *J. Mar. Biol. Ass.*, 25, 555 (1942).
[5] Gortner, R. A., "Outlines of Biochemistry" (2nd Ed. John Wiley, New York, 1938), p. 276.

A Middle Pleistocene Discovery in the Anglo-Egyptian Sudan

ARTEFACTS in type similar to the Chellean, early Acheulean, and Acheulean of the fourth stage of East Africa have been found *in situ* in ironstone gravel only 5 m. above the present flood plain on the banks of the Khor Abu Anga, a left-bank tributary which joins the Nile a kilometre downstream from the confluence of the Blue and White Niles. Late Acheulean implements and a few artefacts of Levallois type apparently associated with them have also been found on the surface; and it is hoped before long to find them *in situ* too.

Similar assemblies have also been found farther downstream on the left bank between Khor Abu Anga and the Sabaloka gorge.

These discoveries mark an important stage in the study of the history of the Nile basin. Besides showing that erosion levels had nearly reached those of the present day long before the Sebilian silts were deposited below Wadi Halfa, and that a pre-Sebilian lake extending as far as the Sabaloka hills is most improbable, they indicate the way by which further study will yield a more complete view of the history of the two Niles, and will link up the succession of events in East Africa and the Belgian Congo with those in Egypt and the Mediterranean region generally.

Evidence has also been found in favour of regarding the ironstone gravels of the district as of sedimentary detrital origin, derived from the local Nubian series. The previous view[1] that these were lateritic '*marram*' and indicated a comparatively late 'lateritic' climate is without foundation[2], as no trace of general 'lateritization' of the included boulders or artefacts can be found, nor is there any lateritization of subjacent deposits, whether rock (Nubian series) or gravels and sands.

G. ANDREW.
A. J. ARKELL.
Office of Commissioner for Archæology
and Anthropology,
P.O. Box 178,
Khartoum. Nov. 11.

[1] Sandford, *Quart. J. Geol. Soc.*, 91, 367 (1935).
[2] cf. Edmonds, *Geol. Mag.*, 79, 29 (1942).

EVOLUTION OF WIRE TELEPHONY

GEORGE H. GRAY, writing in *Electrical Communication* (20, No. 4; 1942) gives a brief historical review of the progress achieved in telephone wire transmission systems since the early days of the telephone, followed by a discussion of the important economic implications of the newer broad band systems, the 12-channel carrier and coaxial cable. The review is divided into four periods. Plant additions permitted advances during each period in at least three of the following respects: conversation distance, transmission channels obtainable from a pair of conductors, frequency band transmitted and, hence, improved quality and naturalness of conversation, and reliability of service.

The first period, dating from 1876, ended about 1900. Although conversation then was virtually still limited to one per pair of wires, reliability of service and transmitted quality had been improved and the transmitting distance increased considerably, due largely to the use of copper instead of iron wire, better insulators, improved line construction and carefully designed transposition schemes. These changes involved no additions to the inside plant and no increased complications in the outside plant other than the necessity for properly maintaining the transpositions. Using 4·19 mm. copper wire, conversation under favourable conditions was possible by the end of this period over distances of nearly 1,600 km.

The second period, from 1900 to about 1915, saw the introduction of phantom circuits, loading coils and quadded toll cable. These changes resulted in a 50 per cent increase in the circuit capacity of a pair of wires and in slightly more than doubling the transmitting distance of open-wire circuits. The use of underground toll cable, of course, improved the reliability of service. Loading, however, limited the frequency band which could be transmitted, and in some cases this was confined to frequencies below approximately 1,800 cycles, affecting the quality of the transmission accordingly.

The introduction of loading coils also reduced the speed of transmission, thus bringing about potential difficulties from transient and echo effects ; this was not particularly objectionable at the time as the circuits involved were comparatively short. The inside plant was made slightly more complex by the phantom repeating coils, and the loading made necessary certain precautions in the maintenance of the outside plant. In general, however, this period added little to plant complexity.

The third period, 1915–37, included the introduction of some radically different and very important types of plant, such as the vacuum tube repeater, the four-wire circuit, one- and three-channel carrier systems, and radio links.

During the last few years of the second period, interesting service results had been obtained with 'mechanical' repeaters, consisting essentially of combination microphones and telephone receivers, but this was abandoned soon after the advent of the vacuum tube repeater. The latter at once more than doubled the transmitting distance of open wire circuits and, by making possible the removal of open wire loading, permitted the transmission of an increased band width. In cable circuits, repeaters permitted a reduction in the weight of loading and hence an increase in the band width and speed of propagation. The four-wire circuit greatly increased the transmitting range for cable. The three-channel carrier made it possible to obtain nine circuits from an open wire phantom group where only three could be obtained before. By combining transoceanic radio links with land circuits, the transmitting range was increased to such an extent that a conversation around the world was held in 1935 over the route New York–London–Amsterdam–Java–San Francisco –New York, approximately 36,000 km. These advances were not obtained without an increase in the complexity of the plant. It became necessary to maintain repeaters, carrier terminal equipment, radio terminal equipment, special transposition schemes, etc., but, on the whole, no very serious difficulties were encountered. This was due, in no small measure, to special plant personnel training courses conducted at appropriate intervals.

Thus, vacuum tube repeaters and three-channel open wire carrier systems made possible a practically unlimited increase in transmission range and an improvement in transmission quality. Their introduction, moreover, influenced toll-rate decreases appreciably, although outside plant expenditures remained a fairly large factor in the cost of furnishing toll telephone service. Consequently considerable attention was devoted to possibilities of further reductions in outside plant costs.

With near-zero-equivalent circuits already available on conductors approaching the minimum size imposed by mechanical limitations, the most promising solution seemed to be a further increase in the number of circuits obtainable per pair of wires. This involved an increase in the frequency band transmitted and, unfortunately, greater transmission losses and cross-talk due to the application of higher frequencies.

The negative feedback repeater, special transposition schemes for open wire lines, the separation of the 'go' and 'return' conductors in cables, special entrance cables, very careful balancing of all circuits, improved filters, dry metallic modulators, and demodulators, and many other developments made possible the application of higher frequencies to existing types of plant and paved the way for the next period in the history of wire transmission systems.

The fourth period, now well initiated, commenced about 1937 and may be designated as the 'broad band' period of wire transmission. The more important developments include the twelve-channel open wire carrier, the twelve-channel cable carrier and the coaxial cable. Although definite predictions would be somewhat premature, present indications are that progress during this period will exceed even that of the previous period.

Loading performed an important service in improving transmission, but the necessity for transmitting a wider frequency range at higher speeds has now brought about its abandonment for the highest grade of circuits in both open wire and cable.

In the case of twelve-channel systems, it might be thought that elimination of loading and the necessity for frequencies up to 60 kc./s. would prevent their commercial application. Actually, however, attenuation of 1·29 mm. conductors in twelve-channel cable systems is about 2·6 db./mile at 60 kc./s., a value which is quite admissible since it is practicable in this case to work the channels at an attenuation of approximately 60 db. per section with repeaters spaced at intervals of about 35 km. Development of these repeaters has progressed to a point where about two out of every three repeater stations generally can be operated unattended.

The reasons for this high permissible attenuation are very low outside interference at high frequencies and the use of separate cables for the two directions, or, alternatively, a single copper-screened cable to reduce interference between the go-and-return channels. The limit of amplification, or attenuation, is determined by the signal-noise ratio ; low outside interference and low cross-talk result in decreased noise. Speech or transmission signals, therefore, may be correspondingly reduced ; that is, very high level differences between the beginning and end of a cable section are permissible.

An inherent advantage of twelve-channel systems, highly significant from an economic point of view, results from the importance of installing cables sufficiently large to provide adequately for future growth. Since cable cost represents the greater part of the total outlay for a non-carrier system, the initial investment in cables is ordinarily great, and full realization of returns must be deferred until they are worked at full capacity. In twelve-channel systems the initial investment, on the contrary, is relatively low, and terminal equipment can be added when required ; moreover, a better balance between outlay and revenue can be attained over the entire period of use.

It should be emphasized that no attempt was made to reduce the width of the frequency band when the number of channels was increased. Long experience and extensive research have demonstrated the importance of transmitting a relatively wide frequency band. A wide band width, moreover, makes it possible to reduce the transmission level, especially if the noise is low, while if the transmission loss in a long-distance link is reduced to zero, the total allowable losses can be concentrated in the local networks with considerable decrease in their cost. Further, this loss may be increased by several decibels for the same overall effective transmission if the width of the transmitted frequency band is adequately increased. To derive the full benefit from the widening of the band, the subscribers' apparatus—transmitter and receiver—must be capable of producing and reproducing this band ; such apparatus has been developed and introduced into commercial use.

The propagation velocity over twelve-channel cable systems is instantaneous for all practical purposes. Even on the longest lines, therefore, speech quality is not appreciably diminished by echoes or other phenomena due to low propagation speed, and therefore lines may be interconnected at will.

Because of the advantages of the twelve-channel carrier cable system, the General Post Office in Great Britain immediately adopted it for its principal toll networks, and the first of such systems was installed in England even before the close of 1936. Shortly thereafter systems were installed in other countries, including the United States, France, Rumania, Sweden, Finland, Holland and Belgium.

For use where very large numbers of telephone circuits were needed and for television, which requires cables capable of transmitting a frequency band of at least 2 mc./s., consideration was given to the application of coaxial cables, the speech channels of which are counted in hundreds. Even for cables of small diameter, frequencies of the order of several megacycles per second can be handled and, since telephone channels are spaced at 4 kc./s., several hundred voice channels can readily be made available.

In Europe, coaxial cables have been laid in Great Britain, France and Germany. In the United States, a 150 km. cable containing two 6·7 mm. coaxial lines has been installed between New York and Philadelphia and another four-line 300 km. coaxial cable recently was placed in commercial telephone service between Stevens Point, Wisconsin, and Minneapolis, Minnesota.

The external conductor, at least above 50 kc./s., serves as a very effective screen against external interference. Hence, very low signal levels, permitting attenuation of 45–60 db. per section between repeaters, are acceptable. In a cable of 6·7 mm. internal diameter, intervals of about 8 km. between repeaters are thus admissible with a frequency band extending up to 3 mc./s.

In coaxial cable systems, the total attenuation for a long line is very high ; for example, a 1,000 km. coaxial cable (6·7 mm.), capable of transmitting a frequency band suitable for 300 telephone channels, would have an attenuation of about 4,500 db. Since reception levels must be maintained within about ± 1 db., repeaters must have a high degree of stability, and the net result is a permissible tolerance of about 0·01 db. per repeater. Furthermore, from the point of view of distortion and noise, these repeaters must meet stringent requirements. A very satisfactory solution is provided by the application of feedback repeaters.

The attenuation of the cable itself, either of the coaxial or twelve-channel type, varies with temperature, so that very long circuits, especially if in aerial cables, necessitate the introduction of compensation devices. For underground cables, manual compensation may be used ; for aerial cables, automatic compensation is required due to more rapid temperature fluctuations. Recently a simplified regulating method using devices known as 'thermistors', the resistance of which varies with temperature in the required manner, has been developed and is expected largely to replace the former rather complicated mechanism.

Although the new transmission systems available in this fourth period of development make use of apparatus which at first glance may appear complicated, there seems to be no reason, based on extensive experience to date, to expect any more serious reaction from their application than was encountered with innovations during the other three periods.

The coaxial repeaters, especially, do not require auxiliary equipment. Furthermore, they may be installed in small, simple structures, or be enclosed in metallic housings placed on poles or in underground chambers. The relatively large number of repeaters necessary is no cause for concern. Experience has demonstrated conclusively that the manufacture of repeaters involving minimum risk of breakdown is a practical proposition ; in addition, arrangements are such that either an individual repeater or a complete cable and repeater section may be replaced automatically by a reserve repeater or a complete reserve section.

The new systems represent a most important advance in long-distance communication engineering. Moreover, their development has progressed to the point where they can be considered commercially stabilized to the extent that no radical modification in the structure of cables, repeaters or terminal equipment is to be anticipated. It therefore seems evident that such broad band systems can confidently be taken as the basis for studies of new networks, affording possibilities of rate reductions and of effecting an extraordinary development in high-quality long-distance telephone communications. Further, their advent makes practical, in many instances, provision for the introduction of television networks on an international scale.

Advances during the first two periods were effected largely with material and apparatus placed in the field, that is, 'outside plant'; those of the third period depended largely on central office equipment. While an important element in progress during the fourth period doubtless must be credited to central office equipment, such as the terminal apparatus for the coaxial and twelve-channel systems, it appears that a new essential factor will be the adaptation of apparatus heretofore regarded as central office equipment to utilization in the field. This new apparatus, as previously indicated, has been embodied in unattended repeater stations.

ASSOCIATION OF UNIVERSITY PROFESSORS AND LECTURERS OF ALLIED COUNTRIES

GENERAL MEETING

THE Association of University Professors and Lecturers of Allied Countries in Great Britain marked its third general meeting with a whole-day session on December 16. The Association, which now comprises 230 members, works through twelve sections (see NATURE, December 12, p. 692), most of which had separate meetings, followed by a general meeting of all members. At this general reunion, reports were presented by the chairmen of groups of sections, and general recommendations made. Thus the deliberations of the individual sections were brought together, to present an inter-Allied view on matters in different domains of actual knowledge. Complete liberty of academic thought and spirit, with such freedom of speech as would be impossible in the countries of continental Europe, characterized the proceedings.

The main points of the aims and work accomplished by the groups of sections were as follow:

Arts: Law, economics, humanities and history, such as studies of comparative law; the position of economic science in the different countries; establishment of a scientific basis for economic planning; the possibility of reaching an agreement on the question of general history; and considerations relating to an international language.

Science: Inter-Allied collaboration for the establishment of an international academy of medicine; the establishment of an international body of information, and the co-ordination of inventions and scientific discoveries in general; an international research centre; collaboration with the Leith-Ross Committee; the establishment of liaisons with British organizations which are studying the planning and reconstruction of Europe; the examination of problems concerning the moral and material sustenance of scientific men in comparison with the manual worker.

General: Dealing with general subjects and with questions of general interest for university men; for example, contacts between British and foreign scholars in Great Britain during the War; the promotion of international collaboration after the War; reconstruction and planning of science and learning in the occupied countries, and the problems of the re-education of youth after the War in Allied and enemy countries.

Prof. R. Douglas Laurie, honorary general secretary of the Association of University Teachers, announced that all members of the Association of University Professors and Lecturers of Allied Countries were invited to become honorary members of the Association of University Teachers. This will lead to closer working and social unity between British and Allied professors and lecturers.

In the course of an address by the president of the Association, Prof. S. Glaser (Poland), the various steps were mentioned which the Association has so far been able to make to promote the necessary collaboration between scientific workers and other scholars of the Allied countries. The reconstruction of moral values as well as the rebuilding of institutions of all categories constitutes, he said, one of the aims towards which the Association is exerting its efforts. This is being carried out, so far as possible, with a profound sense, both spiritual as well as cultural, of the importance of European society as a whole after the War.

It was decided at the general meeting, among other matters, that a conference on a fairly large scale on education should be arranged for the early spring 1943, and a sub-committee under the chairmanship of Sir Alfred Zimmern (Oxford) has been appointed for this purpose.

In NATURE of December 12, a list was given of the general officers and chairmen of sections of the Association. The following can now be added to the list. Section 3: Reconstruction of science and learning in the occupied countries (*Chairman:* Mr. Willard Connely). Section 9: Medicine as distinct from general science (*Chairman:* Dr. Jean-Edouard Bigwood). Section 10: Technical Science and Engineering, has been placed in Section 6 (Science).

Thanks to the efforts of the Association, very useful collaboration between members in the field of learning and scientific research is being established among the various professors and lecturers of the Allied countries. It provides an opportunity of establishing unity in the true sense of the word, namely, with intellectual and moral solidarity; a fact the importance of which will be appreciated by scientific men and other scholars of the Allied countries, wherever their interests in the plans and problems of to-morrow may lie.

THE WAIRARAPA (NEW ZEALAND) EARTHQUAKE OF JUNE 24, 1942

A PRELIMINARY report on some of the seismological aspects of the Wairarapa earthquake of June 24, 1942, has been issued by the Department of Scientific and Industrial Research, New Zealand (*Dominion Observatory Bull. S*-66, Wellington, New Zealand, September, 1942).

Following a rather strong fore-shock at 8.14 p.m. on June 24, the major shock occurred without further warning at 11h. 16·5m. p.m. (New Zealand Daylight Saving Time). Considerable damage to old or poorly constructed buildings occurred at Masterton, where the intensity appeared to be 8+ on the Rossi-Forel scale. There were no fatal casualties, though minor injuries were caused by falling debris. Intensity 8 on the Rossi-Forel scale was attained over a large part of Wairarapa, and the intensity in Wellington City was between 7 and 8. There was evidence of surface faulting at a point 8 miles east of Masterton, and running from a point about 10 miles north-north-east of this point to about 30 miles south of it.

The area over which the shock was felt extended from about Auckland in the north to Dunedin and Queenstown in the south, the latter place being 470 miles from the epicentre. The epicentre, determined from seismographic evidence and supported by field evidence, was near lat. 40·9° S., long. 175·8° E. The focal depth was probably normal. Earthquake sounds, usually low rumblings, and luminous phenomena, usually blue or green flashes, were reported from numerous places in both islands.

Up to June 30, 418 aftershocks were recorded by the seismographs at Wellington, 300 of these being within 24 hours after the main shock. None of these shocks was a large one, but on August 2 at 00h. 34m. a.m. N.Z.D.S.T. a shock nearly as severe as the initial one occurred. Some further damage was caused, chiefly to buildings previously damaged, and occasionally to buildings repaired after the first shock in which the mortar had not had time to harden.

The Wairarapa district has been shaken previously by earthquakes on March 5, 1934, August 6, 1917, April 12, 1913, August 4, 1904, and in 1855, epicentres not always being in the same place.

FORTHCOMING EVENTS

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

Tuesday, February 23

ROYAL ANTHROPOLOGICAL INSTITUTE (at 21 Bedford Square, London, W.C.1), at 1.30 p.m.—Dr. I. Zollschan: "How to Combat Racial Philosophy".

ROYAL COLLEGE OF PHYSICIANS (at Pall Mall East, London, S.W.1), at 2.15 p.m.—Dr. S. A. Henry: "The Health of the Factory Worker in War Time" (Milroy Lectures, 1).

CHADWICK PUBLIC LECTURE (at the London School of Hygiene and Tropical Medicine, Keppel Street, London, W.C.1), at 2.30 p.m.—Prof. M. Greenwood, F.R.S.: "Social and Industrial Environment and Disease".*

MANCHESTER LITERARY AND PHILOSOPHICAL SOCIETY (in Room No. 7, The University, Manchester), at 5 p.m.—Dr. J. H. Shaxby: "The Human Senses, especially Sight and Colour Vision".

INSTITUTION OF CIVIL ENGINEERS (RAILWAY ENGINEERING DIVISION) (at Great George Street, Westminster, London, S.W.1), at 5.30 p.m.—Mr. A. S. Quartermaine: "Railway Construction in Great Britain under War Conditions".

Wednesday, February 24

ROYAL SOCIETY OF ARTS (at John Adam Street, Adelphi, London, W.C.2), at 1.45 p.m.—Mr. P. E. Cross: "Agriculture To-day and To-morrow", 5: "Extension of Market Gardening into Agriculture".

Thursday, February 25

BRITISH SOCIETY FOR INTERNATIONAL BIBLIOGRAPHY (at the Science Museum, Exhibition Road, South Kensington, London, S.W.7), at 2.15 p.m.—Annual General Meeting. Mr. E. Lancaster-Jones: "The Operation of a Microfilm Service". Symposium on "The Classification of Maps and Plans for Territorial Planning" (to be opened by Mr. E. Carter).

ROYAL COLLEGE OF PHYSICIANS (at Pall Mall East, London, S.W.1), at 2.15 p.m.—Dr. S. A. Henry: "The Health of the Factory Worker in War Time" (Milroy Lectures, 2).

Friday, February 26

ROYAL INSTITUTION (at 21 Albemarle Street, London, W.1), at 5 p.m.—Prof. L. P. Abercrombie: "The Inter-Action between Town and Country Planning".

CHEMICAL SOCIETY (in the Lecture Theatre of the Chemistry Department, University College of North Wales, Bangor), at 5.30 p.m.—Prof. T. P. Hilditch, F.R.S.: "Some Aspects of the Chemical Constitution of Milk Fats".

CHEMICAL SOCIETY (JOINT MEETING WITH THE UNIVERSITY CHEMICAL SOCIETY) (in the Chemical Lecture Theatre, The University, Sheffield), at 5.30 p.m.—Prof. J. M. Gulland: "Aspects of Nucleotide Chemistry" (Tilden Lecture).

Saturday, February 27

MALACOLOGICAL SOCIETY (at the Linnean Society, Burlington House, Piccadilly, London, W.1), at 2.30 p.m.—Annual General Meeting and Commemoration of the 50th Anniversary of the Society's Foundation.

LIGHT RAILWAY TRANSPORT LEAGUE (at Fred Tallant Hall, Room J, Drummond Street, London, N.W.1), at 3 p.m.—Dr. Hugh Nicol: "A Scientist Looks at Transport".*

APPOINTMENTS VACANT

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

ASSISTANT MASTER TO TEACH MATHEMATICS, WITH SOME PHYSICS OR CHEMISTRY, in the Sheffield Junior Technical School for Boys—The Director of Education, Education Office, Leopold Street, Sheffield 1 (February 24).

LECTURER IN ELECTRICAL ENGINEERING—The Clerk to the Governors, Heanor Mining and Technical School, 30 Mansfield Road, Heanor, Derbyshire (February 24).

TEACHER (MAN) OF PHYSICS in the Junior Technical School—The Principal, Technical College, Church Street, Barnsley (February 26).

CHAIR OF MINING—The Secretary, The University, Edmund Street, Birmingham 3 (March 1).

INSTRUCTOR IN BEEKEEPING—The Education Officer, County Hall, Wakefield (March 1).

ASSISTANT WITH KNOWLEDGE OF RUSSIAN, GERMAN AND OTHER EUROPEAN LANGUAGES—The Deputy Director, Imperial Bureau of Animal Breeding and Genetics, King's Buildings, Edinburgh 9 (March 5).

MASTER TO TEACH MATHEMATICS AND SCIENCE in the new Junior Technical School Building Course for Boys, Bingley Technical School—The Divisional Education Officer, Education Offices, Bingley, Yorks. (March 7).

SIR DORAB TATA READER IN PHARMACEUTICAL CHEMISTRY in the Department of Chemical Technology—The Registrar, University of Bombay, Bombay, India (April 15).

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

RESEARCH ASSISTANT—The Director, Research Association of British Flour-Millers, Old London Road, St. Albans, Herts.

REPORTS and other PUBLICATIONS

(not included in the monthly Books Supplement)

Great Britain and Ireland

Selected Papers from the Royal Cancer Hospital (Free) and the Chester Beatty Research Institute. (Published by order of the Governors of the Royal Cancer Hospital (Free), London.) Vol. 1, 1935–1939. Pp. xii+484. (London: Royal Cancer Hospital (Free).) 16*s*. [201

Thorley's Farmer's Diary and Almanack, 1943. Pp. 48. (London: Joseph Thorley, Ltd.) 6*d*. [201

Other Countries

Indian Forest Bulletin No. 112: Interim Report on the Manufacture of Kraft Paper from Bamboos. By M. P. Bhargava and Chattar Singh. Pp. v+13. (Delhi: Manager of Publications.) 7 annas: 8*d*. [81

Canada: Department of Mines and Resources, Mines and Geology Branch: Geological Survey. Paper 42-7: Preliminary Map, Takla, British Columbia. By J. E. Armstrong. 10 cents. Paper 42-11: The Pinchi Lake Mercury Belt, British Columbia. By J. E. Armstrong. Pp. 18+map. 10 cents. Paper 42-12: Preliminary Map, Vassan-Dubuisson, Abitibi County, Quebec. By G. W. H. Norman. 10 cents. Paper 42-13: Preliminary Map, Beresford Lake, Manitoba. By C. H. Stockwell. 10 cents. Paper 42-14: Preliminary Map, Gem Lake, Manitoba By C. H. Stockwell. 10 cents. (Ottawa: King's Printer.) [81

Reports of the Biochemical Research Foundation of the Franklin Institute. Vol. 6, 1940–1941. (Newark, Del.: Biochemical Research Fund.) [151

Commonwealth of Australia: Council for Scientific and Industrial Research. Bulletin No. 146: An Analysis of the Outbreaks of the Australian Plague Locust (*Chortoicetes terminifera* Walk) during the Seasons 1937–38 and 1938–39. By Dr. K. H. L. Key. Pp. 88. Pamphlet No. 110: The Main Virus Diseases of the Potato in Victoria. By Dr. J. G. Bald and A. T. Pugsley. Pp. 40+4 plates. Pamphlet No. 114: Plant Introduction. 1: A Review, with Notes on Outstanding Species, by Dr. A. McTaggart: 2: Preliminary Selection and Evaluation of Pasture Species at Lawes (Queensland), by T. B. Paltridge. Pp. 30. (Melbourne: Government Printer.) [201

Faculdade de Ciências da Universidade do Pôrto: Instituto de Antropologia. Da Raca e do Espérito. Por Prof. A. A. Mendes Corrêa. Pp. viii+306. A Escola Antropológica Portuense. Por Prof. A. A. Mendes Corrêa. Pp. 60+19 plates. (Pôrto: Universidade do Pôrto.) [201

Asociación Espanola para el Progreso de las Ciencias. Perspectivas duma Antropologia Citológica. Por el Dr. A. A. Mendes Corrêa. Pp. 16. (Madrid Asociación Espanola para el Progreso de las Ciencias.) [201

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