"NATURE", April 24, 1943

SUPPLEMENT: RECENT SCIENTIFIC and TECHNICAL BOOKS

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

Vol. 151, No. 3834 SATURDAY, APRIL 24, 1943 ONE SHILLING & SIXPENCE

NATURE

No. 3834 SATURDAY, APRIL 24, 1943 Vol. 151

CONTENTS

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

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

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

CONTROL OF CHEMICAL AND MINERAL PRODUCTS

IT is generally agreed that the restraint of potential aggressors must be a prolegomenon to any planned reconstruction of the post-war world. History does not provide us with any comforting hopes in this connexion, but during this last German war the tempo of destruction, cruelty and misery (and also that of lying and slandering) has risen so greatly, and physical means of communication and control have developed so rapidly, that the prospect of curbing Mars, if not of slaying him, may no longer be regarded as chimerical. It is also generally agreed that the measures prescribed to this end at Versailles in 1919, and in subsequent treaties and pacts, have failed dismally. In what directions, then, shall we now look ? Having experienced the futility of pious pacts and the boomerang effects of vindictiveness, shall we now pin our faith to an effective international police force ? Shall we make ourselves overwhelmingly strong, and keep our potential enemies so abjectly weak that they cannot have recourse to war ? Or could we by some political *tour de force* succeed in segregating or dispersing dangerously hostile populations with the view of incorporating them in some stable, peace-abiding confederation ?

In the long run, the will to war might be eradicated by what is called a 'change of heart' ; in the shorter run, much progress in the desired direction could probably be achieved by a drastic reform of current educational methods, and by implementing an all-round policy of social security. But long before such changes could be effective, some means—political, economic, technological—must be taken to cut the claws of any lurking beast of prey, if only to give the world breathing-time to recover from its present plight. If the beaten enemy is again allowed to attain a 'giant's strength', he will again not hesitate to 'use it like a giant'. At the same time, it is well to remember that "Who overcomes by force, hath overcome but half his foe".

Any one nation that undertook to make and keep itself overwhelmingly strong in the military sense would incur a crippling economic burden, a grave deflexion of man-power from truly constructive to purely destructive ends, and an unhealthy maintenance of the martial spirit. To keep potential enemies in a permanently weak state, physically, economically and politically, would foster among them a sense of frustration, bondage and injustice, and thus sow the seeds of a future war. In any event, for many years to come we must learn from our fateful experience of the past one hundred and fifty years, and be prepared militarily for a sudden emergency ; and any long-term policy we adopt must be so conceived that, while restraining the martial powers of potential aggressors, it does not jeopardize the success of any future eirenicon.

The profound horror evoked by the mass murder of non-combatants, by the brutalities committed in concentration camps, and by the persecution of Jews and other subjugated peoples might readily lead to ruthless repression and even to biological reprisals. Such policies would, however, be virtually sentence of extermination ; they would do nothing for the betterment of human relations. Like greed, vindictiveness can easily overreach itself.

A less drastic, and probably a thoroughly practical proposal, would be to place an embargo on the importation of certain raw materials that are essential to war-time use. This was the policy put forward, in respect of 'key' minerals and metals, by Sir Thomas Holland before the South African meeting of the British Association in 1929, and again under the same auspices at the Conference on Mineral Resources and the Atlantic Charter, in July 1942 (see NATURE, Sept. 26, 1942, p. 364). No nation possesses within its own territory all the resources that would be adequate to conduct a long war, or for that matter to thrive economically in time of peace. For example, Germany and other parts of central Europe lack nickel, manganese, chromium, tungsten, cobalt, molybdenum and vanadium, and such substances cannot be produced synthetically, like petroleum, rubber, fibres and camphor. In view of the development of carrier-aircraft, there might well be difficulty in preventing the importation of 'key' materials required only in relatively small amount, for example, platinum and the rarer metals and minerals, but in general such a ban on exotic 'key' materials would do much to deprive an aggressive Power of the means of continuing a protracted war, provided always that there was an international authority adequate to control the ingress of supplies.

Another method of disarmament was suggested by Sir Robert Robinson at the annual luncheon of the Parliamentary and Scientific Committee, namely, to prevent the manufacture of war-time explosives by abolishing all large-scale plants making synthetic ammonia, and plants making methanol, as these can be used for making ammonia. In this way, the large-scale production of nitric acid, which is the basis of practically all explosives used in war, could be effectually stopped. No explosives—no war, was his thesis.

It may be recalled that before the War of 1914–18, nitric acid, for all purposes, was made almost exclusively from Chile saltpetre by interaction with sulphuric acid, but that shortly before its outbreak, Germany had elaborated and established the Haber-Bosch process of making ammonia by fixation of atmospheric nitrogen, the ammonia being oxidized to nitric acid by the Ostwald process. By this means Germany made herself entirely independent of imported nitrate for the manufacture of explosives and for use as fertilizer. After that War, many countries, including Great Britain, adopted the Haber-Bosch process, a modification of it, or some other process of fixing atmospheric nitrogen. To-day there are many such plants dotted over the civilized world ; and of recent years their combined productive capacity has been well in excess of peace-time demands. The result is that none of these countries need, in case of emergency, import a single ounce of Chilean nitrate (though there is plenty of it still available). The synthetic ammonia works in Germany (but not the ammonia-oxidation plants) are concentrated in a few centres, and Sir Robert Robinson believes that an International Nitrogen Commission would have little difficulty in maintaining the 'sanction', though he would allow the manufacture of sulphate of ammonia after a term of years. No mention was made, however, of the fact that a very large amount of ammonia is obtained as a by-product in the manufacture of metallurgical coke and of town's gas. There is little doubt that the works producing these products could be considerably enlarged or the number of them be increased ; the gas-works are widely dispersed, and supervision of them would entail a vast amount of police work.

The elimination of the huge synthetic ammonia works, and the ensuing drastic reduction in output of nitric acid, would put a temporary check on the production of explosives, but it would also have other consequences. It would deal a very serious blow to various peace-time chemical industries in the controlled countries, and so react adversely on their economic status. Ammonia, besides being used for the manufacture of nitric acid and such important fertilizers as sulphate of ammonia and ammonium phosphate, is also used in the manufacture of alkali by the Solvay process, and as a refrigerant, etc. Nitric acid has also a multiplicity of applications. It is of paramount importance in the manufacture of dyes and intermediates ; in fact, it is difficult to imagine a dyestuffs industry without it. There is also to be considered the possibility, if its large-scale manufacture from synthetic ammonia were banned, that another technical process of manufacture might arise in its place, such as one based on the use of ammonifying and nitrifying bacteria, which play so important a part in agriculture.

Among other 'key' chemicals of which the production might come under the ban, sulphuric acid is of first importance, being used not only in the manufacture of explosives, like nitroglycerine, gun-cotton and T.N.T., but also in a host of other industries, either as a starting material or for purifying and refining purposes. Although a process for making sulphuric acid from calcium sulphate (as gypsum or anhydrite) was worked out in Germany about the time of the War of 1914–18, practically all of it is still made from sulphur, obtained mainly from the United States, or from pyrites, derived chiefly from Spain or Norway. It would probably be much easier to prohibit the importation of these raw materials than to police a whole country with the object of preventing their use in sulphuric acid plants. Of other chemicals, apart from metals and metallic compounds, that are needed for war-like purposes, it may be said that the majority can now be produced from indigenous raw materials. Thus phosphorus, for use in incendiary bombs, etc., can be extracted from bones and low-grade phosphatic minerals ; glycerin, which is normally derived from natural fats and fatty oils, can now be made synthetically ; calcium carbide, ethyl and methyl alcohols, ether, acetic acid, acetone and formaldehyde, phenols and urea needed for plastics manufacture—all these can be produced from raw materials that are close at hand.

It appears doubtful, therefore, whether the suppression of the large-scale manufacture of 'key' chemicals, or, in fact, of any vital manufactured product, would be so promising as a measure of restraint as the control of the importation of 'key' minerals and metals. Both suggestions will have to be given careful consideration. But for any such measure to be really effective, there must be a much greater degree of co-operation among the peace-loving Powers than any we have seen in the past. Disarmament in the literal sense will no doubt be the first step, the *terminus a quo* for the long, long journey to the *terminus ad quem*, international pacification, the speed of which would be accelerated by some far-sighted political action, such as the dispersal of potentially hostile or recalcitrant minorities into regions where they would be harmless, and the incorporation of them into larger peace-abiding confederations possessing the maximum amount of freedom consonant with international security.

JOHN RAY

John Ray, Naturalist
His Life and Works. By the Rev. Dr. Charles E. Raven. Pp. xix+502. (Cambridge: At the University Press, 1942.) 30*s*. net.

NO one who studies with attention the historical development of biology can be long in doubt as to the place to be assigned to John Ray. It may be, as Dr. Raven suggests, that his name is not so well known to present-day biologists as it was to those who founded the Ray Society a hundred years ago; but, if so, it must be because the present-day biologist tends regrettably to be uninterested in the history of his science and, no less regrettably, to regard classification as no concern of his. Not that Ray imagined, as Linnæus did, that systematics was the end and aim of natural history; but to the botanists and zoologists of the seventeenth century, faced by the bewildering variety of living things, classification was the primary and most pressing need. Ray approached the problem in a spirit in many ways surprisingly modern. Others had arranged animals and plants as fitted the subject under discussion, geographically, ecologically, or on the basis of their utility to man. It was Ray who first clearly expressed the conception of a 'natural' classification based solely on structural resemblances and differences; it was he who first discussed the still unanswered question: 'What is a species?' It is true that he had no inkling of a genealogical basis for classification, but no one had in the seventeenth century.

Ray's fame has been to some extent overshadowed by that of his great successor Linnæus, but, as Dr. Raven says, "there can be no sort of doubt that Ray had the truer appreciation of the real task of a scientist". Linnæus had, in a superlative degree, the pigeon-hole type of mind. Had he lived in our times he would have been a great deviser of card-indexes and filing systems. He invented a method of 'running down' the species of plants which made botany a popular pastime with the dilettanti of the eighteenth century. His system of binomial nomenclature is still used for labelling our museums and herbaria, and no one has yet suggested a workable substitute; but in all that concerns the structure and life-processes of organisms he was far from showing Ray's knowledge or insight. Sachs' judgment that Linnæus "never made a single important discovery throwing light on the nature of the vegetable or animal world" will scarcely be disputed nowadays.

Hitherto it has been difficult to form any clear idea as to what manner of man this was whom Gilbert White called "Our countryman, the excellent Mr. Ray". He has been singularly unlucky in his biographers. His friend Dr. Derham, who wrote a sketch of his life and published his "Philosophical Letters" (selected from a much larger number now lost), intentionally omitted most personal details and concentrated on what he supposed to be of scientific importance; "of this", Dr. Raven drily remarks, "he was not always a good judge". Edwin Lankester, who edited Derham's "Life" and a further selection of letters for publication by the newly founded Ray Society, was ill-equipped for the task. The late Dr. R. W. T. Gunther, in the "Further Correspondence" published by the Society in 1928, brought to light a considerable number of unpublished letters and reduced to order much of the chaos created by previous editors, but did not try to tell a connected story.

Now at length we have a worthy biography, scholarly and sympathetic, which is not likely to be soon superseded as the standard authority on Ray's life. Dr. Raven, indeed, deplores that his lack of systematic training in biology disqualifies him from pronouncing judgment on Ray's position in the history of science, but it is not quite certain that this lack is matter for regret. He has escaped, at any rate, the myopia of the specialist and, on the other hand, he is, like Ray, an experienced and enthusiastic field-naturalist. "I have collected nearly all the plants, birds and insects that he records, and often in the same localities." Like Ray he can say "Divinity is my profession", and as a humanist he can appreciate Ray's "masterly" Latin, his interest in philology, and his pioneer work in the study of English dialects.

In all the mass of Ray's correspondence that has survived there are remarkably few references to his personal affairs. The letters are concerned almost exclusively with scientific matters and seldom reveal, even by accident, anything of the man himself. He had been corresponding with Edward Lhwyd for some ten years when the death of his little daughter Mary breaks down his habitual reserve. "You may possibly have heard, though I do not remember I ever told you, that I had four daughters." Dr. Raven points out that letter-writing of this impersonal kind was the means by which men of learning kept in touch with each other until "periodicals and meetings of learned societies superseded it and . . . means of communication made travel and talk easy".

Dr. Raven alludes to the "unpleasant controversy" that arose about a century ago as to Ray's share in the "Ornithology" of Francis Willughby which Ray edited and published after the death of his friend. The controversy was futile as well as unpleasant, for it is quite possible to regard Willughby as a pioneer ornithologist without deriding Ray as an "amiable and gentle" botanist. As Dr. Raven points out, there is ample evidence that Ray was "a scientist of genius" and Willughby "a brilliantly talented amateur".

In an eloquent tribute to Ray's "fascinating and heroic personality" Dr. Raven writes of him as "The blacksmith's son who in an age of almost feudal class-consciousness won for himself reverence and friendship and that without sycophancy or aggressiveness; the fellow of Trinity who when consciences were elastic gave up everything sooner than declare that the Covenant which he had not subscribed was no oath . . . the writer who in the last twenty years of his life, straitened in means and racked with pain, produced some fifteen new books, including the 3,000 folio pages of the 'History of Plants', the 'Synopses' of animals, reptiles, birds and fishes, the first serious treatises on science and religion and in addition some nine revised editions of these and earlier works; the naturalist who, in the last decade of the century, with the help of his four little daughters bred and described the life cycle of nearly three hundred local lepidoptera."

Dr. Raven says of Gunther's volume of "Further Correspondence" that it is "marred by some carelessness in editing". The present writer's consciousness that he must take to himself a share in this reproof has perhaps sharpened his perception of some very minor blemishes in a book which he has read with great pleasure and admiration. Why does Dr. Raven say of Dale's "Life of Ray" which Gunther published from a manuscript found in the Bodleian, "Dr. Gunther was apparently not aware that it had been printed before"? Gunther explicitly says "Dr. Andrew Clark printed it some ten years ago in the 'Essex Review'". The slip of "have" for "had" in the sentence quoted about the middle of p. 64 would not deserve mention if it were not that the context makes the tense tragically important.

W. T. Calman.

THE ART OF GLASS POLISHING

Prism and Lens Making

A Text Book for Optical Glassworkers. By F. Twyman. Pp. iv+178. (London: Adam Hilger, Ltd., 1942.) 15*s*. net.

THE literature relating to modern methods of glass grinding and polishing is scanty, perhaps because this is traditionally a hand craft, differing little in essentials from the practice of three hundred years ago, and each worker guards jealously the methods handed down to him as valuable professional secrets. Though machines for glass polishing were projected by Descartes and others, there is no record of these being successful until Lord Rosse constructed the machine for making his large astronomical reflectors; this reciprocated the polisher on the revolving work and seems to have standardized this stroke, regarded as the only one satisfactory for accurate 'figuring' until the late Mr. W. Taylor, twenty-nine years ago, showed the feasibility of the more efficient round-stroke machine.

The book under review is distinctive as being written by the managing director of one of the best-known English optical firms, whose work is justly world-famous for scientific precision. Moreover, the firm has developed quantity production of optical elements to serve the needs of Great Britain in two wars, so that experience in two directions, quality and quantity, is embodied. The author specifically limits himself to the methods in use at Adam Hilger, Ltd., and this limitation constitutes both the strength and the weakness of the book; on one hand, because actual working methods are described by one who is familiar with them; on the other hand, the scope of one firm's work is necessarily restricted and methods which are admirably adapted to its own work may not invariably be best for other classes of work. The machines and technique of other firms are scarcely recognized. For example, the trepanning of glass to produce lens blanks is not alluded to, and it is assumed that lens surfaces are polished, and the edges ground, by machines which reciprocate the work across the tool. The author, in the disarming words of the preface, disclaims superiority for his own methods and "hopes that those manufacturers who may be using other, and perhaps better, methods may be willing to give me the benefit of a full knowledge of them"; but Mr. W. Taylor has already published descriptions of his own machines.

The layman who learns that an optical surface can be made to an accuracy of a millionth of an inch, or that two surfaces can be made with the angle between them accurate to a second of arc, is impressed. He is puzzled when he finds that the dimensions of optical elements cannot easily be guaranteed to the same accuracy as machined parts. In fact, the optician is content with thousandths of an inch where the engineer talks of ten-thousandths. Mr. Twyman explains how the accuracy of surface and angle can be attained and tested, but is less definite in explaining the limiting factors in working optical elements to size. In fact, the book is weak on the subject of dimensioning.

The manufacturer, for whom the work is primarily intended, will be particularly grateful for the information on materials, especially for the figures relating to pitch. Strangely enough, no poet has risen to sing the wonders of pitch, the optical worker's most valuable ally. It is the basis of his polishing operation and the means by which he holds his work, retaining it firmly without rigidity and releasing it quickly and cleanly when required, without scratching the delicate polished surface. By its colour it forms the perfect background for the examination for polish and for testing by Newton's rings. The old-time worker gauged its quality by a sort of Brinell test; the constant temperature chamber was his mouth and the Brinell ball his teeth! Mr. Twyman more scientifically measures the rate of penetration of a loaded blunt needle, and gives figures for the different pitches and Canada balsams he finds suitable. As illustrative of the differences of opinion prevalent, Dr. Preston and Colonel Crompton considered this procedure untrustworthy: the former prefers a loaded ball while Dr. J. W. French uses a disk. There is thus unfortunately no correlation between the figures given by these different workers.

Undoubtedly the section of the book that will command most attention is that devoted to the working of flats and prisms. Here Hilger's authority is unquestioned. Many of the jigs described are of Mr. Twyman's invention. The method of holding the roof prisms so that the angle can be tested in working is particularly ingenious, and so is the polishing machine for making single flats of high accuracy. It is interesting to note the use of the flexed rod for applying pressure, a device shown in Zahn's "Oculis Artificialis" of 1685. Hilger's use it to apply local corrective pressure.

Another section of great importance is that devoted to the testing of optical work. The author is chiefly concerned with the accuracy of flat surfaces and of parallelism or angle between two surfaces. The interferometer and other instruments developed mainly by the author and his co-workers for this purpose are fully dealt with, and so great is the author's belief in scientific methods (and faith in his workmen) that "every optician in the Hilger workshops has free access to these instruments", for "entirely unskilled boys and girls can in a week or two be taught not only to test prisms and lenses . . . but to correct the optical performance by retouching the surfaces". It is to be hoped that the author will "retouch" this last statement when he realizes its implications, for there would surely seem to be no excuse for the slightest imperfections in camera lenses or microscope objectives, and the favourite disclaimer of the optical writer that no optical system is perfect will be untrue.

The work is enriched by historical notes, a bibliography and an index. Misprints are few and unimportant (except the misspelling of Dr. Burch's name) and the most serious omissions from the bibliography are W. Taylor's presidential address to the Institute of Mechanical Engineers, 1932, and W. Ewald's "Die Optische Werkstatt".

In a review criticism is necessarily prominent, but it would be misleading the reader to leave him with any other impression than that the defects of Mr. Twyman's book are slight in comparison with its merits, which should ensure it a hearty welcome from manufacturers and workers and all interested in the fascinating subject of glass working ; it is also a valuable contribution to the war effort.

H. W. LEE.

AERIAL PHOTOGRAPHY AND GEOLOGY

Aerial Photographs

Their Use and Interpretation. By A. J. Eardley. (Harper's Geoscience Series.) Pp. xii+203+46 plates. (New York and London : Harper and Brothers, 1942.) 2.75 dollars.

WITH the frequent publication of aerial photographs, usually of some sector of enemy territory, the military value of such photographs is generally appreciated. But aerial photographs have been used for many other purposes since they were first introduced more than eighty years ago. In themselves detailed though rather distorted maps, they can form the basis of the preparation of detailed topographical maps, and even of the refined maps needed for some engineering projects. Aerial photographs have also been used for the determination of the distribution of crops, for making forest inventories, and for various geological purposes. Further applications have been made in studying marsh ecology, and silting and soil erosion. Apart from their many uses, aerial photographs have other valuable features which are emphasized especially with regard to those taken over enemy territory, for they provide information about regions difficult of access far more quickly and, in many respects, in much greater detail, than could be obtained by ground methods in a reasonable time and at a reasonable cost.

"Aerial Photographs : their Use and Interpretation", a revised edition of "Interpretation of Geologic Maps and Aerial Photographs" by A. J. Eardley, deals mainly with the geological applications of aerial photographs. Eardley writes clearly and simply, so that no preliminary knowledge of aerial photography is required before reading his book. Cameras, flying technique, types of photographs, scale determination, and the limitations and the stereoscopic examination of aerial photographs are briefly described in the introductory chapters, which contain much of the basic material found in the U.S. Army field manuals on the use and interpretation of aerial photographs. Only a brief reference is made to photogrammetry, which is a matter for the expert equipped with elaborate instruments ; but the simple instruments and methods whereby contoured maps of a small area covered by a few prints may be prepared might well have been more fully described, for the author notes that at times it may be necessary to produce such maps without expert aid. There is a short description of the technique of stereo-sketching, and a fairly detailed discussion of the compilation of mosaics, from which discussion the method of drawing maps without contours may be deduced.

Patterns of outcrop, photographic guides for tracing contacts, and structure, contour and cross-section construction are the broad headings under which the geological interpretation of aerial photographs is considered. There are also short chapters on oblique photographs for reconnaissance mapping, on the interpretation of culture, and on tactical (military) interpretation. The text is supplemented by forty-four excellent aerial photographs (verticals, mosaics, multi-lens composites and obliques, printed like the rest of the book on good quality paper) which show what a valuable aid aerial photographs can be to ground-work under favourable conditions, and how they may give great detail as well as bring out features that may not be observable on the ground or that may become apparent only as a result of prolonged investigation. A further forty-eight figures are included, among them many diagrams showing the outcrops of an area, first as a map and then as the corresponding block diagram.

Geologists and others will be deeply interested in the aerial photographs and in the accompanying discussion. In particular, the thoughtful consideration of Eardley's remarks on structural geology may be recommended to all geology students, for the ability to "restore the strata step by step, if only hypothetically, to their original position of deposition" by logical steps, thereby making an interpretation which "is at least a logical possibility", must be sought by all who would elucidate the structure and geological history of an area.

The aerial photographs of this book were selected to "show clearly the features used in geologic interpretation", and therefore they may "give an exaggerated impression of their value in geologic work. Photographs of many areas will reveal little of interpretative value, and in other areas only faint clues of geologic features may be recognized. However, photographs of such areas are very valuable when taken into the field and used as base maps for charting the geologic rock formation and land forms." While remembering the limitations of aerial photographs and that the photographs reproduced in this book have been specially selected, geologist readers in Great Britain, and, indeed, others also, may well be excused envy of their colleagues in the United States, two thirds of which vast country has been photographed from the air. Perhaps it is not too much to hope that photographs taken in war-time photographic flights over Great Britain, and containing geological information, will eventually reach the Geological Survey and Museum, where they would probably be of assistance to this country's official geologists, and might ultimately be made available to other geologists.

A few errors and ambiguous statements occur in the introductory chapters, and some of the marginless photographs have suffered in trimming. Points such as these can easily be corrected in future editions of the book, in connexion with which the inclusion of several stereoscopic pairs of aerial photographs seems to be worthy of consideration. If the photographs take the form of separate plates inserted in a pocket at the end of the book, they should be of considerable value to any reader who has access to a stereoscope or who has constructed a simple stereoscope according to the author's instructions.

G. D. HOBSON.

EDUCATION AS A SCIENTIFIC STUDY

The Study of Education in England

By Prof. F. Clarke. Pp. iv+60. (London: Oxford University Press, 1943.) 2*s*. 6*d*. net.

AS in the War of 1914–18, and indeed at all times of social upheaval, the pamphlet is much in evidence. One of the latest and best is Sir Fred Clarke's pamphlet or 'little book', which goes to the roots of educational reform in Great Britain. His experience, first in England, then for many years at Cape Town and at Montreal, and then as adviser to overseas students at the London Institute of Education, of which he is director, places him in a unique position for surveying the whole vast educational problem (an aspect of the vast social problem) which gradually unrolls itself as this War goes on. His taste does not take the form of writing large books. He prefers the way of the pamphlet and the magazine article, thrown off as occasion arises or as the inspiration comes. But his pamphlets are so packed with matter that they amount to treatises in disguise. The pages of this latest example, "The Study of Education in England", contain more "thought to the square inch" than the reviewer has for some time encountered.

The author's task of advising visitors, chiefly from the United States, the Overseas Dominions and the Colonies, has naturally been extended to others who have taken refuge in this extraordinary little island, which stood undaunted when all the world thought its fate was sealed. They want some light thrown upon the secret of England's greatness, and in particular they want to know all about the educational system under which her young citizens have grown up.

There the author's troubles begin, for instead of a system inquirers seem to find something very much like chaos. They find the most private and exclusive of schools called 'public' schools, and schools which stand before them in solid visibility called 'non-provided'. They find that we ourselves never quite know what we mean by the terms elementary, secondary, cultural, vocational, technical, boarding, private, public, and so on, as applied to schools. They have to learn how deeply all are infected by motives and considerations that are far from being educational. Seeing that education in England is closely bound up with her social structure, they ask for a book in which the story is told, and they are amazed to learn that no such book has ever been written, though (the reviewer would add) there are very good books on the history of schools abstracted from the rest of the social scene. Seeing that English becomes more than ever a world-wide language, they may ask what has been done to simplify the learning of English as a foreign language, and the answer is that nothing has been done except by private effort. If they ask what provision is made for the study of comparative education, the reply is that there is no public provision, that there once existed an excellent department of special inquiries and reports, which was virtually ended, or at least crippled, by an eminent and perhaps an over-zealous Civil servant.

On the other hand, inquirers should be told of valuable work done by the Board of Education in issuing pamphlets and circulars, and by the reports of its Consultative Committee; of the mass of valuable material accumulated by local education authorities, mostly hidden away in their archives; of the research work done in university training departments and training colleges, and in departments of psychology; and of the serious studies of educational problems promoted and financed by voluntary organizations of teachers and social workers. All this is to the good, and most of it points, says the author of this pamphlet, to the crying need of central organizations for educational research, such as already exist in Scotland, Australia, New Zealand, Canada, and South Africa.

In these lands the wheels of progress run with relative smoothness. Why not in England? Why is it that in England the spirit of scientific research in education is conspicuous by its absence, except as a private venture? The reason is that England has relied upon tradition and has not cared for "the critical organising authority of science". That is the lesson she has yet to learn, and it is for the enforcement of that lesson that this pamphlet has been written. "It is, perhaps," says Sir Fred Clarke, "no accident that in England the great strongholds of educational tradition should also have become the entrenched positions of a 'class' interest, a ruling class interest"—a state of affairs which, as he states with obvious claims to authority, "stands out with striking prominence in the eyes of observers who are acquainted with those examples of another English tradition, the United States and the Dominions". In a comparatively trivial sense we talk of our "dual system". The real dual system of English education resides in the fact that for about 10 per cent of the population, selected largely by wealth, we have 'private' or independent schools, not forming part of the State system, which has produced the great majority of the holders of key positions in Church and State, whereas for the vast majority there is the 'State' system as it has evolved since 1902. Sir Fred devoutly hopes that the two will not be left to fight it out, since the result either way could only be disastrous to national education as a whole. He is far from joining in any attack on the public schools. His anxiety is lest the exclusive and separatist attitude of the minority section may prove to have endangered the tradition itself, including its most valuable elements. The easy-going reliance upon tradition must be abandoned, and along with it must go that lack of interest in serious studies on the part of those who have the control of national education, that startling ignorance in high places of the conditions under which the great mass of the people of England are educated, and that "double-mindedness" that is "induced in a dominant minority which, in defending a concept of education, is also defending a social stratification closely bound up with it".

The author wisely refrains at this stage from attempting to draw up a detailed programme for action. He does, however, indicate the broad conditions which any organized scheme for the study of education in England will have to fulfil, and in doing so he has in mind not only the needs of England herself, but also the wide variety of cultural and social conditions amid which the ideas shaped in English conditions will have to be adopted and interpreted.

To one who has lived through the last six or seven decades, who has seen at close quarters how the State system of education has been administered and supervised by men who relied upon their prestige and their own tradition, and who regarded the pretensions of the psychologist and even the sociologist with a disdainful smile, this call for clear thinking, for the scientific approach, and for ending the period of well-meaning muddling through, is indeed refreshing.

T. RAYMONT.

BRITISH AND VIENNESE MEDICAL SCHOOLS

British Medicine and the Vienna School

Contacts and Parallels. By Dr. Max Neuburger. Pp. 134+13 plates. (London: William Heinemann (Medical Books), Ltd., 1943.) 10*s.* 6*d.* net.

IN his preface Prof. M. Neuburger remarks that though an intensive study has been made of the history of the medical faculty of Vienna and its connexion with the medical schools of Padua, Leyden, Paris and Germany, a similar work on the correlation of the Vienna and British medical schools had been lacking. He has therefore undertaken to remedy this omission, inspired by the affection for his *alma mater* and his admiration for the pioneer achievements of British investigators and physicians. The period covered by the book extends from the middle of the eighteenth century, in which the chief medical men in Vienna were van Swieten and De Haen, who were both followers of Sydenham, and in Great Britain Fothergill, Lettsom and Willan, down to the first quarter of the present century, in which the most notable figures were Nothnagel, Wenkebach, Pirquet and Freud in Vienna, while Hughlings Jackson, Osler and Clifford Allbutt were the most outstanding physicians in Great Britain.

Relations between the two countries were mainly established by visits of British physicians to Vienna and of Viennese physicians to London and other parts of Great Britain, as well as by translations of medical works into English or German. The most notable British visitor to Vienna was Richard Bright, who in 1818 published the "Travels from Vienna through Lower Hungary with some Remarks on the State of Vienna during the Congress" (1814), in which he gives an account of the celebrated "Allgemeines Krankenhaus" and university museums of Vienna.

About the same time William Mackenzie, the famous ophthalmologist, spoke highly of the arrangement of the clinics for internal diseases, diseases of the eye, and obstetrical departments which he had inspected. About twenty years later William Wilde of Dublin, equally celebrated as an ophthalmologist and otologist, in his work on "Austria, its Literary, Scientific and Medical Institutions" (1843), gave an account of the departments of morbid anatomy, of which Rokitansky was the director, of ophthalmic surgery and diseases of the chest directed by Skoda. During his honeymoon in 1856, Lister spent three and a quarter hours with Prof. Rokitansky, whom he described as the most eminent pathologist in the world.

In 1874 Felix Semon, who received his special training in otolaryngology in Vienna, spoke of the postgraduate courses there as exemplary. Osler about the same time also paid a visit to Vienna, where he attended the clinics of Hebra the dermatologist, Widerhofer the pædiatrist, Politzer the otologist, Brava the obstetrician and Billroth the surgeon. Thirty-four years later he returned to Vienna on the occasion of a medical congress.

On the other hand, the principal Viennese medical men who visited London were Josef Frank, the chief physician to the "Allgemeines Krankenhaus", Hebra the dermatologist, Arneth the obstetrician, Beigel the gynæcologist, Politzer the otologist and Hajek the laryngologist.

As regards translations of Viennese writers, special mention must be made of the publications of the Sydenham Society (1843–57) and the New Sydenham Society (1859–1907), which included translations of von Feuchterleben's "Principles of Medical Psychology" (1847), Rokitansky's "Morbid Anatomy" (1849–52), Prochaska's "Functions of the Nervous System and Unzer's Principles of Physiology" (1851), Hebra's "Diseases of the Skin" (1866–80), Stricker's "Human and Comparative Histology" (1870–73), Billroth's "Surgical Pathology" (1877–78), Salzer's "Healing-in of Foreign Bodies" (1894), Neumann's "Pemphigus Vegetans" (1897), Sternberg's "Acromegaly" (1899) and von Lembeck's "Clinical Pathology of the Blood" (1901). Other translations into English of works by eminent Viennese physicians were Plenck's "New and Easy Method of Giving Mercury to those Affected with the Venereal Diseases" (1767), Skoda's classical "Treatise on Auscultation and Percussion" (1853), Türck's "Clinical Research on Different Diseases of the Larynx, Trachea and Pharynx" (1863), Stellwag's "Text-book of Practical Ophthalmology" (1868), and Zeissl's "Outlines of the Pathology and Treatment of Syphilis and Allied Venereal Diseases" (1886).

Translations of outstanding works by British writers into German included Mason Good's "Diseases of Prisons and Poorhouses" (1799), John Thomson's "Lectures on Inflammation" (1814), Hodgson's "Treatise on the Diseases of the Arteries and Veins" (1815), Christian's "Granular Degeneration of the Kidneys" (1839), J. R. Bennett's "Causes, Diagnosis and Treatment of Acute Hydrocephalus" (1844), Forbes' "Homœopathy" (1846), Ferrier's "Functions of the Brain" (1879), Morell Mackenzie's "Diseases of the Throat and Nose" (1880) and Braid's "Neurypnology" (1881).

Prof. Neuburger is to be congratulated not only on his admirable survey but also on his mastery of English. The text is interspersed with portraits of van Swieten and De Haen, Maximilian Stoll, Johann Peter Frank, Lucas Johann Boer, Richard Bright, Rokitansky, Skode, Sir William Wilde, Hebra, Semelweiss, Osler, and an engraving of the Allgemeines Krankenhaus. A short bibliography of English and German works is appended. There is no index, but this is in some degree compensated for by a table of contents and is possibly attributable to the paper shortage.

J. D. ROLLESTON.

THE FLORA OF BOMBED AREAS*

By PROF. E. J. SALISBURY, C.B.E., F.R.S.

THE vegetation which develops spontaneously on the derelict bombed areas clearly provides us with a means of assessing the efficiency of the diverse methods of dispersal of the constituent species. But in utilizing their study for this purpose several factors must be taken into account.

Many such areas present ruined houses of such a character that there is little or no exposed soil upon which plants can grow. The activities of demolition squads or reconstruction labourers may partially or entirely preclude the possibility of plant growth. Hence the poverty of the flora on many sites cannot be adjudged as evidence of inefficient dispersal.

In general, the most diverse floras in the London area are to be met with towards the west, and there tends to be a diminished diversity of species as we pass eastwards towards the City. This trend can doubtless be attributed in part to the direction of the prevailing winds but also in some measure to the increasing frequency and size of gardens in the West End which provide sources of weed and other seeds.

In determining the variety of the flora, the efficiency of the dispersal mechanism exerts the major role in determining the range of occurrence in suitable habitats. The number of the areas examined in which any particular species has been observed, that is, its frequency, will be used to give us an approximate measure of the efficiency of its dispersal. The number of individuals of a particular kind on any one area, that is the abundance on a site, may also be an indication of efficiency of dispersal or merely of subsequent spread.

After the great fire of London in 1666, it is recorded by Ray that the ruins around St. Paul's were abundantly colonized by the London rocket (*Sisymbrium Irio*), but 150 years later the plant would appear to have become a rare plant and I have entirely failed to find a specimen on any of the sites examined. Of all the plants of our bombed areas the most frequent, though often not the most abundant in the early stages of colonization, is the rosebay willowherb (*Epilobium angustifolium*), a plant we often associate with burnt areas on heaths. The greater frequency of heath fires which accompanied the advent of the motor-car and the growth of cigarette smoking is probably in large part responsible for the rapid spread of this wild flower in recent years. In Hertfordshire, for example, the rosebay willowherb was a scarce plant half a century ago whereas it is now common throughout the county, and a similar change has taken place south and west of London also. Thus there are to-day sources of seed supply all around the Metropolis.

The association of the rosebay willowherb with burnt areas is probably due to a variety of causes among which, not the least important, is that its seeds only germinate freely in well-illuminated areas, and the occurrence of a fire usually ensures freedom from shade.

Secondly, soil which has been subjected to heat is known to be somewhat toxic to many plants until after the lapse of some weeks when, through oxidation, the deleterious chemical substances have been rendered innocuous. But some plants, notably certain mosses such as *Ceratodon purpureum*, and *Funaria hygrometrica*, the liverwort *Marchantia polymorpha* and the rosebay willowherb, are especially tolerant of such conditions and are all striking and characteristic features of the 'old hearths' in the West of England woodlands where charcoal-burning is still carried on. These plants can therefore develop before the soil becomes sufficiently favourable for other competitors to flourish.

Again, growth of the willowherb is markedly stimulated by nitrates, and the production of these may be promoted by burning in two ways; first by the fertilizing action of the ash constituents, which also stimulate the growth of the willowherb directly, and secondly, by the partial sterilization of the soil. That it is such indirect effects, rather than direct effects, of the fires which favour the willowherb's growth is indicated by the abundance and frequency which it exhibits on woodland clearings where similar soil changes accompany the sudden access of light.

A relatively small plant of rosebay willowherb will produce two hundred seed-pods each of which may contain nearly four hundred seeds, so that a young plant might well yield about eighty thousand seeds in a single season, while the yield of a large adult individual would far exceed that figure. Each seed is about a millimetre in length and bears some seventy long silky hairs forming an effective parachute which opens out in dry air but closes when the air is moist. The whole thus forms a beautiful and most efficient aid to dispersal by air currents, which is brought into action under conditions most favourable to the carriage of the seeds.

We can, therefore, scarcely be surprised that the rosebay willowherb is one of the first flowering plants to appear on bombed sites or that it should have been found on nearly ninety per cent of those examined. Owing to its spread by means of underground shoots, it tends to form dense patches which may extend over a yard in a season, and this feature, combined with the height it can attain and its perennial character, render the plant a successful competitor against other species, and quite commonly, where established some time, it becomes the dominant type. But when Curtis wrote his famous "Flora Londiniensis" nearly 170 years ago, the species was evidently only a garden escape in the London area and still infrequent a century later.

Second in importance both as to frequency and abundance is the common groundsel (*Senecio vulgaris*). The average seed production is much lower than that of the willowherb, numbering about 1,100 potential offspring per plant; moreover the groundsel is much shorter and an annual. In addition to their dispersal by wind, the fruits become sticky when moist, owing to which they are liable to be carried on the boots of pedestrians and the feet of birds. But the rather small output per plant is compensated by the fact that several generations of plants ripen their fruits in a favourable season, and unlike those of some of its congeners the fruits will germinate at almost any time of the year when the temperature is favourable.

Two other members of the genus Senecio are conspicuous and common features of bombed sites, and both have an interesting history. The commoner of these, found on 56 per cent of the areas, is the so-called Oxford ragwort (*Senecio squalidus*), a native of Sicily, which in its native home frequents volcanic ashes, so may well find the site of a burnt-out building a congenial habitat. The first record for Great

* Substance of a Friday Evening Discourse at the Royal Institution on February 19.

Britain is at Oxford in 1794. There Sir Joseph Banks noted the plant as growing plentifully on the walls and in and about the city. Cultivated specimens are in Bobart's herbarium, so that there can be little doubt it was grown in the Botanical Gardens at Oxford and thence escaped to become naturalized in the neighbourhood. But though we next hear of the plant in Berkshire, the other counties to which it spread during the nineteenth century were not the contiguous ones, but north Devon (1835), Worcestershire (1836), west Suffolk (1849), east Kent (1875), Buckinghamshire (1897), and west Sussex (1898). At the present time the Oxford ragwort is to be found in approximately 62 per cent of the English counties as well as to a limited extent in Ireland and Scotland. In London the Oxford ragwort was first recorded in 1867. The greater prevalence towards the south is in accord with the plant's Mediterranean origin.

The fruits of the Oxford ragwort are larger and heavier than those of the groundsel and less readily carried by the wind. An average-sized plant will probably produce between fifteen and twenty thousand fruits as compared with the 1,100 of the groundsel. Still, if the latter produced two generations only in a year, compared with the one of the Oxford ragwort, the potential offspring at the end of the season would be well over a million. Some of the fruits of the Oxford ragwort may germinate in the autumn, but the majority would appear to germinate in the spring.

The sticky groundsel (*Senecio viscosus*), which was found on 45 per cent of the sites, is easily distinguished from the common groundsel by the much larger size to which it can attain and by the covering of sticky glandular hairs. The chief home of the species is southern Europe, and it is perhaps native as far north as Belgium. It is probably an introduction to Great Britain, although some botanists have claimed the species as native to certain coastal districts. The sticky groundsel was first recorded as growing in Great Britain by Ray in 1666, from banks in the Isle of Ely, but, despite its possible sojourn in England of nearly three hundred years, only during the past twenty-five years has the rate of spread of the sticky groundsel been rapid. Thus in 1915 the number of counties in which the species had been recorded was only slightly larger than in 1900, though it should be noted that these embraced additional areas far removed from the main southern group. Between 1915 and 1940, however, this groundsel had been recorded in no less than fifty-two of the seventy-one English counties and vice-counties and from twenty-seven of the forty in Scotland.

As a casual the sticky groundsel was found near the Caledonian Hospital in 1838 and de Crespigny records its occurrence near Kensington Railway Station in 1887. Now it is to be found on nearly half the derelict sites, and on some of these it is common or even abundant.

Each head produces an average of about seventy-three fruits, whilst the number of fruit-heads per plant is about eighty-four. Hence the normal production of fruits by a single plant would be about six thousand. But one very large plant, on which the fruiting heads were counted, had produced no less than 1,196, or an output of approximately eighty-six thousand fruits.

Despite the southern provenance of the sticky groundsel it is comparatively hardy, and I have found plants still flowering after spells of frost when the temperature fell to 23° F.

Another very common and frequent plant on our sites is the coltsfoot (*Tussilago Farfara*). Here the fruits are very small and bear a silky parachute of hairs which ensures wide dispersal; moreover, as with the rosebay willowherb, there is rapid vegetative spread which accounts for the large colonies that it soon forms.

The coltsfoot is very tolerant of heavy clay soils and has always been a feature of vacant sites in the suburbs, where mortar rubble remedies the deficiency of calcium in the London clay. The early ripening of the fruits enables the seedlings to pre-empt a place in the sun before the arrival of competitors. Each head may produce some 300 fruits, and as many as twenty or thirty heads may occur in a tuft, representing a possible output of between 6,000 and 9,000 fruits.

The seedling will form inflorescence buds in the autumn of the first year and these flower the following spring, whilst other axillary buds develop as rhizomes at the ends of which additional rosettes of leaves and tufts of flowers are formed. By means of these underground shoots, which may attain to a length of thirty inches, a large area can soon become occupied by the leafy rosettes, whilst the connecting rhizomes between them die and decay in about three years after their formation. From these facts it will be appreciated why the coltsfoot is so efficient a colonizer and so pernicious a weed.

Another plant, which though present on only about 40 per cent of the areas examined, is normally abundant where it does occur, is the Canadian fleabane (*Erigeron Canadensis*).

The history of this North American species would appear, so far as Europe is concerned, to begin about 275 years ago when, according to tradition, it appeared on the Continent from seeds which had dropped out of the stuffed skin of a bird. For Great Britain, the first record appears to be one from the London area some twenty years later. In 1836 it occurred on old walls at Chelsea, at Hampton Court and elsewhere, whilst by the time de Crespigny wrote his "New London Flora" in 1877 the Canadian fleabane was frequent on waste ground in London and especially on the railway embankments that had been constructed, as an outcome of the new means of transport developed during the early 'forties of the last century.

By the end of the nineteenth century the plant was established as an alien weed of waste places in some ten counties south of the line from the Bristol Channel to the Wash. Now it is to be encountered in most of the English counties south of Yorkshire, in a few of the Welsh counties as well as in the south-eastern parts of Scotland.

The seeds germinate in the autumn and pass the winter as rosettes which send up a flowering stem in the following summer. A large plant was found to bear about 6,500 flower-heads, and the average is well over seven hundred. The number of fruits which each head produces is about thirty-five. Each fruit is small and flattened, about a millimetre in length, and bears at the tip a parachute of some twenty-five toothed hairs.

Kerner von Marilaun estimated that an average plant would produce 120,000 fruits, and the large plant just referred to would have yielded about 233,000 fruits. It will be apparent, therefore, that the production of fruits by the crops of plants such as we see occupying some of the bombed sites must be prodigious.

Other common members of the same family on the bombed sites are the sowthistle (*Sonchus oleraceus*) and the dandelion (*Taraxacum officinale*), but there is one member of this group which, although found on only about 14 per cent of the areas examined, is of particular interest. This is *Galinsoga parviflora*, a native of Peru, that was first recorded as a naturalized plant in England as a garden weed at Richmond in 1860 and two years later from Middlesex. It had originally been cultivated in the Gardens at Kew in 1796, whence it spread to the immediate surroundings.

The fruits from one head are of two types. The small number of white ray-florets produce fruits which are larger than those produced from the central flowers, and each has at its summit five or six short feathery processes which represent the pappus, though far too small in relation to the size and weight of the fruit to ensure dispersal by wind. The yellow tubular flowers, which occupy the central area of the flower-head and number between 10 and 30, produce much smaller fruits. Each of these disk fruits bears a parachute of narrow elliptical, almost petal-like, processes fringed with hairs which facilitate the dispersal of these fruits for short distances by the wind. Both types of fruits are beset with a number of short bristle-like hairs which tend to make them cling readily to rough surfaces, while the flattened form of the fruits facilitates retention. It is perhaps due to this that transport by human agency may occur also.

The larger ray-fruits would appear to be more efficient as a means of ensuring the persistence of the species once it has reached a locality, whereas the smaller fruits, though more susceptible to adverse conditions, are better suited for transport to a distance and thus for the evasion of competition. A moderate-sized plant of Galinsoga will produce about four thousand fruits.

As we might anticipate, several grasses are common on the bombed sites, and of these *Poa annua* is the most abundant, whilst *Lolium perenne*, *Agrostis alba* and *Holcus lanatus* are widely distributed. The presence of these, together with *Dactylis glomerata*, *Poa pratensis*, and also, though more rarely, of oats and wheat, suggests their origin from seeds escaping from the nosebags of horses. To this source also can probably be attributed the frequent presence of red and white clovers (*Trifolium pratense* and *T. repens*), the former on about one quarter of the bombed areas.

Chickweed (*Stellaria media*), though widespread, is by no means everywhere, and this is probably an outcome of the mode of dispersal. The seeds of the chickweed become sticky when moist, and as a consequence are frequently carried on boots or less commonly on the feet of birds. This is true also of the seeds of the ribwort (*Plantago major*), which become mucilaginous when wet. Hence, as we might anticipate, it is especially on those areas where pedestrians can enter with ease that the species just mentioned most commonly occur.

Of the large number of bombed sites examined, many have yielded only a few species, but the total list recorded numbers ninety-five vascular plants. In this assessment no areas have been included which were in part the sites of former gardens, but only such as might reasonably be assumed to have been previously unoccupied by vegetation. The only exception to this generalization is where the species already present were known, so that the new arrivals could be identified.

It is evident from a study of all the species which have been recorded from these sites that wind carriage is by far the most important means by which the seeds and fruits are introduced. The species which are dispersed in this manner comprise 30 per cent of the total. Moreover, if we confine our attention to those species growing on more than one quarter of all the sites, we find that eight of these are dispersed by the wind and only four are dispersed by other methods. Further, the members of the Compositæ which have a parachute mechanism upon their fruits are among the commonest species present, while other members of the same family which do not develop such a pappus, as, for example, the yarrow (*Achillea millefolium*), the mugwort (*Artemesia vulgaris*), the scentless mayweed (*Matricaria inodora*), and the nipplewort (*Lapsana communis*), all occur on only a small proportion of the sites examined, and the pineapple weed (*Matricacia suaveolens*), which has spread so rapidly in recent years, is quite a rare plant.

It is interesting also, in this connexion, that the only garden plant met with on several sites is the purple Buddleia (*Buddleia variabilis*), sometimes in appreciable numbers at considerable distances from possible sources of seed. The ripe capsule contains a number of very light seeds in which the body is minute whereas the seed coat is extended as a flattened wing at each end.

The widespread rosebay willowherb, as previously stated, has plumed seeds and it shares with the plume-fruited groundsel the distinction of being the commonest species. The only other species on these sites with plumed seeds are two species of willowherb, which are both infrequent (*Epilobium montanum* and *Ep. hirsutum*), and the goat willow (*Salix caprea*). Seedlings of the latter tree have been seen on 16 per cent of the areas studied.

In view of the relative inaccessibility of many of the bombed sites, it is scarcely surprising that those species which depend to any appreciable extent for dispersal by carriage on the boots or clothing of pedestrians are generally somewhat infrequent. One might perhaps have expected bird dispersal to be an important means of introduction, were it not for the character of many bombed sites, which may well make them rather unattractive to birds until such time as vegetation has rendered them a source of food.

Elder bush seedlings (*Sambucus nigra*) and the woody and black nightshades (*Solanum dulcamara* and *S. nigrum*) probably owe their presence to this mode of introduction, but the more frequent occurrence of tomato seedlings is, one suspects, a result of human dispersal. Nevertheless, though the species which are probably dispersed mainly by birds are often quite infrequent, they are the next in importance as regards the number of kinds involved, since they comprise 20 per cent of the total. Of the remaining species, probably 14 per cent are mainly dispersed by human agency, leaving some 34 per cent for which the main agent of dispersal is uncertain.

It is evident then that the immigration of these plants is due mainly to the transport of their seeds or fruits by air currents. Some of the seeds, like the spores of the ferns, are so small as to behave like dust particles ; other seeds and fruits present a large surface in proportion to their weight, and this is especially true of those which bear a parachute of hairs.

But observation and experiment show that most of the fruits and seeds shed from a plant do, in fact, fall to earth at no great distance from their point of origin. The common ragwort (*Senecio Jacobaea*), though uncommon on the bombed sites, may serve as an example, since the dispersal of its plumed fruits was studied under natural conditions in New Zealand by Poole and Cairns. Trays were placed at intervals along lines radiating from a group of fruiting plants, and the numbers shed at the different distances were counted. The radiating lines of trays were evenly spaced with respect to the points of the compass, and though more fruits attained the longer distances before coming to earth when travelling in the direction of the prevailing wind than in the reverse direction, the vast majority of the fruits fell within a circle 180 ft. in diameter, with the parent individuals occupying an asymetrical position 120 ft. from the circumference before the wind and 60 ft. to windward. My own experiments with poppies, using an artificial wind created by means of a fan (cf., "The Reproductive Capacity of Plants". Bell, 1942), show the same feature in an accentuated form with the slight difference that since the seeds are here jerked out of the capsule pores, by the action of the artificial gusts of wind on the stiff stalk of the fruits, the maximum fall of seeds was 20–40 in. away from the capsules, not immediately around their base. That this is true also for natural conditions is indicated by field studies on the mullein, where the proportion of seeds attaining varying distances from the parent was estimated from the number of seedlings developing in a uniform habitat. The maximum fall is about 12 ft. from the parent.

Such facts lead us to appreciate that even these highly specialized seeds and fruits fail to attain any great distances by wind action alone, and indeed accounts of wind dispersal have hitherto failed to recognize the fundamental part which is played by upward convection currents in ensuring such dispersal as shall mitigate competition among the offspring.

It has been pointed out by Prof. D. Brunt that, under uniform conditions in still air, if the surface of the soil be heated up by the sunshine, convection cells are formed in which the rising column of heated air ascends for a distance, depending mainly upon the temperature differences involved, and which spreads out and descends at a distance from this rising column approximately equal to the height of the latter. Clearly, a minute seed or a plume fruit caught up in one of these convection currents would be carried up a certain distance and then again brought down at a distance from the parent plant roughly corresponding to the height to which it had attained. The efficacy then will in no small degree turn upon the average height and frequency of such convection currents. I am indebted to Prof. Brunt for the information that convection currents over London might be expected frequently to attain a height of 500 ft., though appreciably greater heights of several thousand feet may sometimes obtain. Their efficacy for dispersal will depend upon the coincidence of the period of ripening of the fruit, commonly early autumn, or late summer, with a period of warm dry weather and sunshine; so, I think we shall agree, that in the English climate it is reasonable to state that very rarely will such conditions coincide with the occurrence of convection currents of more than average altitude.

If no other factor intervened, we might then expect, on the basis of these assumptions, that a species in the London area would spread at a rate of somewhere about a mile in ten years. Actually, we have a rate of advance of this order provided by Galinsoga, which, entering Richmond in 1860, traversed about nine miles in the subsequent eighty-three years, or an average of a mile in rather more than nine years. In windy weather the convection cells of the air are changed in form, but the distance between the upward and downward currents is not appreciably modified. If, however, by a fortunate accident a seed or fruit is carried out of the circulatory air current into the wind current above, it may be carried long distances before again coming to earth.

The larger the surface that the propagule presents relative to its weight, the more chance there is of this happening; hence it is scarcely surprising to find that the rate of spread shown by *Senecio squalidus* and *Senecio viscosus* is not only more rapid but also shows a much more varied rate of extension of its range. For example, the sticky groundsel during the period 1900–15 spread to locations 50–200 miles from the nearest previous habitats, whilst during the next twenty-five years a further discontinuous extension of up to 180 miles was recorded. Species with efficient means of wind dispersal do, in fact, appear to present normally a slow rate of spread around the centres of occupation and also extension to new centres often very remote from the previous stations. These latter may well represent the occasional fruits or seeds which are carried up by convection currents into wind currents that are more than local. If the rate of fall of propagules in still air is determined for different species, their relative efficiency for long-distance carriage can be approximately estimated. It must, however, be realized that the efficiency increases at a more rapid rate than the decrease in the rate of fall.

The following represent averages of a number of determinations in still air of the rate of fall of ripe seeds or fruits of the species concerned and are expressed as the time taken to fall through a distance of 10 ft.

Epilobium angustifolium	33·4 sec.
Senecio vulgaris	10·0 sec.
Buddleia variabilis	5·4 sec.
Senecio viscosus	4·6 sec.
Galinsoga parviflora	3·4 sec.

The rate of fall of the seeds of the rosebay willowherb is seen to be far slower than that of the seeds of Buddleia, but these latter fall more slowly than the fruits of the sticky groundsel or Galinsoga. The individual seeds of the willowherb varied in this respect, probably depending to a great extent upon the development and divergence of the hairs which the seeds bear. One seed fell 10 ft. in 13½ sec., whilst at the other extreme another seed occupied 66 sec. in traversing the same distance. The degree of divergence of the hairs constituting the parachutes of these seeds or fruits is mainly influenced by the humidity of the air, the hairs closing together when the air is damp and diverging more and more as the air becomes drier. It will be apparent that such hygroscopic response not only ensures that the seeds and fruits will tend to be detached from the plant under climatic conditions most favourable for their dispersal, but also that they will tend to come to rest once they have settled on damp soil. It will also be appreciated that the parachute of a seed carried up by a warm convection current of dry air may well exhibit partial closure when it reaches the cooler conditions above, and thus descent down the 'walls' of the 'convection cells' is facilitated.

The facts we have just considered make it apparent that the dispersal mechanisms are in large measure responsible for the high frequency of the rosebay willowherb and the common occurrence of the groundsels. The dust-like spores of the mosses, ferns and fungi, which are commonly encountered on the bombed areas where conditions are favourable to their growth, are almost equally well dispersed, and if any further tribute to the action of upward currents were needed it is furnished by the occurrence of many of the commoner species of these bombed areas on old buildings at considerable heights above the ground.

Actually the order of arrival of the various kinds of plants, though to some extent determined by the nature of the soil and the changes which it undergoes with the passage of time, is in no small degree a measure of the relative efficiency of their means of dispersal.

Dispersal, both throughout the country in general and on the bombed sites in particular, is found to be a dual process—a short-distance dispersal which is more or less continuous in space, and a long-distance dispersal which is strikingly discontinuous and, being dependent upon the coincidence of favourable circumstances, somewhat erratic in its incidence.

Discontinuity, which has always been regarded by biologists as a sign of antiquity, is thus seen to be also an attribute of youth. Where the efficiency of dispersal is low, contiguity of occupation will preponderate, but where favourable environmental conditions are infrequent and dispersal efficient, discontinuity may tend to persist.

FUNCTION AND FUTURE OF UNIVERSITIES

MORE than one organization is discussing the post-war development of university education. A committee of the British Association on post-war university education has been at work on this problem for more than a year and has already published an interim report (Nature, **150**, 716; 1942), and the Association of University Teachers is also discussing a draft report of a committee which has been considering the future developments of university education. It was a happy inspiration, therefore, which caused the Association of Professors and Lecturers of Allied Countries in Great Britain to arrange for a conference at which they could discuss with their British colleagues both the fundamental question of "The Function of a University in a Modern Community" and the equally vital problem of "Methods of Practical Co-operation between Allied Universities in the Future". The conference was held on April 10, by kind permission, in the rooms of the Royal Institution.

Prof. A. L. Goodhart (United States), who presided at the conference, in his opening remarks dwelt on the fact that a reconstruction of the world after the War, if we are to have a permanent peace, must have an intellectual and a moral basis. The purpose of a university is the establishment of truth, but it is not enough to establish truth 'in an ivory tower'. Universities have an active and not a passive part to play in the modern community. We must also realize that education must not stop with youth; it is a life-long function which can never end. Here again the universities can play a leading part by taking charge of adult education, which means the education of the community.

Sir Richard Livingstone expressed the opinion that the modern university has not shown any direct influence on the spiritual and moral life of the world; no influence comparable to that of the University of Paris in the thirteenth and fourteenth centuries, of the English universities in preparing the English Reformation, or of Fichte and others in the early nineteenth century. They have not helped the democracies to create any countervailing philosophy to the teaching of Nazism. They have given the world the guidance it needed in science, economics and sociology, but not in the knowledge of good and evil. Hence they have failed to help civilization where it most needs help. They send into life men who are good political technicians but poor statesmen. The universities should demand of all their students that, in addition to their main subjects of study, they should attend courses in three subjects which are a part of the indispensable equipment of educated men—the influence of science on civilization, religion and philosophy, and so learn something of the fundamental problems of life.

This important aspect of university teaching, so essential for the understanding and future maintenance of peace, was dwelt upon by several subsequent speakers. The evils of the absence of instruction in the fundamental problems of life were stressed by the Minister of Education for Poland, Prof. St. Kot. Magnificent education and technical proficiency obtained without acquiring a knowledge of religion and philosophy are liable to be devoted to the service of evil causes. It is the youth of the universities that fill the ranks of the fanatics—marching, beating up their opponents and terrorizing democratic elements.

The Yugoslav Minister of Education, M. Trifunovitch, in considering the functions of a university, indicated that it may vary somewhat according to the community. In a large and rich country, it might be possible to train considerable numbers of scientific workers, but in a young peasant State like Yugoslavia, it is a luxury and threatens to produce an intellectual and unemployed proletariat. The universities should train the young men, the living force of their nation, to collaborate so effectively that the vitality of the nation might be steadily raised and its material and spiritual progress ensured. The preparation of graduates for certain branches of the Civil Service is one of the functions of the Yugoslav universities, but he emphasized the point that the university diploma itself should not open automatically the royal road to certain higher ranks of the Service; the latter should depend on the subsequent acquisition of practical knowledge and experience.

That the universities, apart from the specialized training they give in the sciences and the arts, should also provide the education for the learned professions is a generally accepted thesis. This should include the training of teachers, of whom, however, only about 20 per cent are directly trained by the universities in England and Wales. If provision should have to be made at the universities for all teachers in training, some 30,000 additional students would seek to enter the universities. Mr. P. R. Morris, director of education for Kent, told the conference that "the attitude of the universities towards this great problem will, in no small measure, determine the influence of the universities on the community at large and also their relationship to the educational system". The universities, he said, must inspire the social ideal of the community. To do so they must themselves be part of the very texture of society and not institutions isolated from society as a whole. Their interest in social problems must be disinterested but not detached.

Prof. J. A. Veraart (Netherlands) gave a very suggestive account of the necessary "Social Reconstruction within the Universities". He considers that during the nineteenth century an individualistic mood took possession both of the lecturers and the students, and that it is necessary after the War that they should foster the feeling that teachers and taught belong to one close community. An important part of the time of the professors should be reserved to enable them to take part in scientific and social gatherings of students. As much personal contact as possible should be made between staff and students, who should feel themselves in the midst of a community in which there is an interest in all their needs, scientific, social and cultural. That is the best means of securing the cultural development of the students, which is furthered more by personal contact than by formal instruction.

On the question of "Co-operation between Allied Universities in the Future", which was dealt with in the afternoon sitting of the conference, there was practical unanimity between both British and foreign representatives as to the need for such co-operation. Various suggestions were put forward as to how this could best be done.

Mr. Kenneth Lindsay, M.P., considers that intellectual co-operation of the savants, spasmodic conferences of specialists and the exchange of professors and students, although good in themselves, only touch the fringe of the problem. Previous attempts at its solution failed, not for want of good intentions but by a lack of a common purpose and adequate machinery. He advocated the creation of an international organization comparable with the International Labour Office of the League of Nations. It could for the moment be preceded by a United Nations Office of Education in London during the War, while there are among us so many distinguished Allied professors and lecturers. They had been responsible for organizing the conference and it should not come to an end without arranging for the continuance of some more permanent form of intellectual co-operation.

The International Education Office which Mr. Lindsay envisaged should examine the main principles of existing systems of education and draw up a model Education Charter as a supplement to the Atlantic Charter. He is also of the opinion that there is a strong case for establishing centres for international study of education and for cultural exchange. In this field he welcomed the work of the British Council. Much could be learned from the notable experiment of the School of International Studies held in Geneva between 1924 and 1939.

Prof. S. Glaser pointed out that Dr. Julian Huxley, in an article recently published in the *New Statesman and Nation*, had suggested the creation of such an international organization, a sort of International Education Office, the task of which would be the consideration and realization of a world education programme. Prof. Glaser thinks that the Association of University Professors could render useful service in creating an International University Institute, which might deal with comparative education and could collect and distribute information concerning the universities of different countries, their regulations, their entrance conditions, fees, degrees, living conditions, etc. It might deal with exchanges of teachers and students, recognition of degrees, and lastly with the organization of international university conferences such as have been already initiated by the Association of University Professors in Great Britain.

Prof. Kot, the Minister of Education for Poland, was equally emphatic that the universities of all Europe should join together in an international association, which would define its own tasks and think out methods of fulfilling them. For after the military victory, there would still remain the enemy that had been reared in the minds of the younger generation in the lands of dictatorship. In the re-education which would have to take place, the universities will have to play a leading part, and they should not hesitate to undertake once more the task of general formulation of a world outlook, involving the transformation of minds and character. It will be necessary to rediscover a common tongue and to inculcate common conceptions into the nations, which in this respect have been severed from one another for many centuries.

It might, of course, be questioned whether universities which are State institutions could work harmoniously with universities which, like those of Britain, are independent of the Government even when they receive subsidies from the latter. British universities have been very careful to safeguard their independence, whereas State universities seem more likely to be absorbed into political strife or authoritarian dominance. Prof. Paul Vaucher, however, in an excellent account of the development of French universities since the days of Napoleon, showed how, in spite of being State institutions, they maintained their spiritual and intellectual independence, and that if they can maintain their academic freedom and liberty of mind, they are perhaps better able to play the part and fulfil the duties assigned to universities in modern communities. The two main objectives of the universities are considered by Prof. Vaucher to be : the training of students in acquiring general knowledge and possibly wisdom, and the promotion of the progress of science by independent research.

Prof. E. J. Bigwood, who was so active in Belgium in connexion with the Hoover Relief Committee after the War of 1914–18, indicated that at that time there was a strong feeling that closer personal relations should be encouraged between Belgian intellectuals and their foreign colleagues. When after the War very large funds of the Hoover Relief Committee became available, two important permanent foundations were created and put at the disposal of all Belgian institutions of higher education : the "Fondation Universitaire" in Brussels, and the Belgian American Educational Foundation in New York. More than six post-graduate fellowships were awarded to young Belgians to spend a year in American universities, sometimes renewed for a second year. At the same time, a limited number of similar awards were made to American students to study in Belgium. In addition, there were certain private foundations which sent Belgian students to Paris and to other foreign universities The effect of the visits of such students was considered in Belgium as of the highest importance for promoting good international feeling, and should be arranged between the universities of other countries.

MODERN INDUSTRY IN THE NETHERLANDS EAST INDIES*

By DR. P. H. W. SITSEN

Netherlands Economic Mission, Washington, D.C.

THE evolution of simple existence to prosperity encounters the same problems everywhere. In modern countries the evolution goes from the stage of self-employment via compulsory labour to modern wage employment. Especially in the field of agriculture, where up to the present day self-employment is still in existence at some places, the stage of compulsory labour was in the beginning represented by outright slavery, while in industry in the beginning labour was compulsory and received only meagre wages.

In modern times social legislation, organized labour, modern banking and the gospel of thrift, fostered in the non-capitalistic classes, made it possible to take care of the future and also to give a fair share of the gains of production to the working classes. The first stage—that of self-employment—was a fairly static one; the second—that of compulsory labour—brought a larger increase of income but only to the entrepreneurs, whose wealth and power grew; the third stage—that of modern wage labour—inaugurated a period of prosperity for an ever-increasing part of the whole population.

In the Netherlands East Indies we find the same evolutionary trend; the stage of general self-employment, with only an irrelevant volume of exports, is succeeded by a period of compulsory labour. Under the influence of the entrepreneur class, a large volume of agricultural and mining products was produced and surplus capital was formed in the same manner as this class fulfilled its mission in industry in Western civilization. The labourers received low wages because the greater part of the production was performed as part-time work by the Indonesian farmer, whose bare existence had been protected from the beginning by agricultural laws.

The development followed the same natural course of events as everywhere in the world. The entrepreneurs made a large amount of money and for the greater part this capital was reinvested in new enterprises, paving the way for new possibilities for the future of the people.

The difference from the development in other countries is that the reinvested capital remained mainly in the hands of the Dutch, the British and, later, the Americans. Dividends and interest payments did not affect the purchasing power of the native population but that of absentee investors. This kind of commercial imperialism has certainly been very advantageous for the entrepreneurs. More and more capital went to tropical regions to be invested in the production of raw material. A keen price competition between the raw material countries caused an interruption in the rise of workers' wages, while the power of the entrepreneur class was seriously threatened.

The extent to which the prices were reduced in the Netherlands East Indies during this crisis can be demonstrated by mentioning that an Indonesian rubber grower could get a sewing machine for 40 lb. of rubber in 1913, as against 240 lb. in 1939; a copra-growing farmer could buy a can of salmon for 2 lb. of copra in 1913, while in 1939 he had to pay with 6 lb. of his product; an Indonesian gum-producer could have a piece of cotton goods for 7 lb. of gum in the former year, whereas he had to produce as much as 20 lb. to obtain the same commodity in 1939.

This very disadvantageous rate of exchange caused a difficult situation internally for the Indonesian workers and farmers and loss of capital and energy to the entrepreneurs. It provided for the Indonesian people and its government, however, the opportunity to show how with united forces such difficulties could be overcome. The Indonesian intellectuals, educated in schools of higher learning, took their fate in their own hands with the help of a progressive group of economists. By degrees they were able to influence the Government, which gradually shifted from a guiding and conciliatory position to a form of almost completely directed economy, with the greatest amount of prosperity for the native population as guiding principle. First of all, the formation of capital, thus far mainly for the good of the absentee capitalist, was fostered in the local Indonesian community. As to commercial capital, here the Indonesian stake had already grown to more than nine hundred million guilders and was increasing rapidly.

The production of the commodity industry, organized by Western methods, tripled in this last decade, while nearly a hundred million guilders of invested capital were in Indonesian hands. Wages in industry rose rapidly. In 1940, the average income of factory workers in industries amounted to about 350 guilders a year. A guilder was equivalent to two American dollars.

The above statistical data on development were reached at a time when buyers of the Netherlands East Indies raw materials drew the main profit out of the total production, and entrepreneurs in the Netherlands East Indies lost a large amount of capital. This may seem paradoxical but it is actually very reasonable, and it is of paramount importance for future developments to understand this economic phenomenon. For example, gradually only 568,000 hectares of the total rubber-cultivating area was in the hands of Dutch and foreign investors, while 1,300,000 hectares were owned by the Indonesians. Of the coffee estates, 107,000 hectares were financed by Dutch and foreign capitalists while 123,000 hectares were brought into production by native capital.

Of a total of about 4½ millions of hectares of land producing raw material, not less than about three millions had come into Indonesian hands. This shift of production from European to Indonesian producers caused an ever-increasing income for the Indonesian people. Moreover, and this is of great importance for the future development of the secondary industry, the overhead costs of European management were much higher than those of Indonesian organizations. Thus, the Indonesian was able to save money and procure new purchasing power for further industrialization.

This happy evolution is, however, pregnant with one great danger. The initiative and the necessary research for nearly all productions now in the hands of Indonesian enterprise has been carried out by European entrepreneurs. I am convinced that the disappearance of this class, so badly needed in economically not fully developed countries, would mean a catastrophic interruption of economic progress. Research could partly be taken over by government-sponsored

* Substance of an address given at the September meeting of the Society of Netherlands Scientists in the U.S.A. at Cornell University.

institutions, but the divulging of realistic knowledge of national and international economic conditions is more difficult for the Government institutions ; and I believe that the taking of initiative and risks lies within the scope of a government in a country like the Netherlands East Indies and should be shared by government and private capital together. It is rather the task of the Government to watch the situation closely and to plan measures through which the power to produce and to consume may be increased.

Four facts have been stressed here. First, that the formation of capital in the Netherlands East Indies formerly mainly increased prosperity abroad and not that of the native society. Secondly, that the formation of capital and the growth of buying power of the Indonesians were reached by the transition of more lucrative agricultural production to native enterprise ; thirdly, that overhead expenses are much higher for Western than for Indonesian organization. Lastly, that technical knowledge, skill and experience until now have mainly been imported. This means that for future industrial development, it will be necessary that more and more technologically stabilized production of raw materials is carried out by Indonesians to promote the further formation of Indonesian capital and income ; that development also should be promoted in secondary industry in order to lower cost prices and to extend consumption ; that the white man's job in the future should not be one in competition on the same level of efficiency with the Indonesian producers, but to introduce new and more complicated forms of organization and technology.

In this decade of evolution in the Netherlands East Indies these new principles have been promoted as well as was possible despite the very disadvantageous rate of exchange between the Netherlands East Indies raw materials and imported consumer and capital goods. The income of the native farmer grew, thanks to his increasing share in the production of export materials. The total population increased 19 per cent during 1928–40. In the same period the total export of raw materials in guilders in 1928 decreased three per cent, but the Indonesian part of it increased sixteen per cent. This new income from agriculture was widely spread and therefore of benefit to all classes.

Thus a large demand for commodities was stimulated. In this same period, the number of mechanized factories was doubled, the number of workers in these was tripled and the output quadrupled, according to statistical data. They show the fact—so important to future evolution—that some time between 1928 and 1940 Indonesian society matured and began to build its own future.

In these years we recognize a continuous growth of small-scale industry—industry with factories of less than fifty workers and with little or no machinery, growing in output as well as in organization.

In this industry—not to be confused with home industry—nearly 1,400,000 men were working in 1930, while in 1940 this total had been increased to 2,600,000. Formerly, this type of production was merely in a stage of self-employment, mainly producing goods for consumption in the home village. In the second half of the last century, a certain degree of insular trade developed, Chinese and Javanese middlemen—the so-called *bakoel*—received most of the profit. These middlemen were as capitalistic as the Western entrepreneurs of the late nineteenth century. Similar to these, they sweated the labourer in order to fill their own pockets and to extend their production. At the same time, they were indispensable to the industry ; they were bankers, suppliers of raw material and distributors, while in some instances some of the more difficult technical phases in the production were carried out under their direct supervision. Their position generally was very strong indeed. In the small-scale textile industry in middle Java, it was found in 1935 that seven key positions were still occupied by these middlemen.

In the last decade, however, this situation was rapidly changing. Small-scale workers, enlightened by vocational schooling, Press and governmental field services, are gradually organizing themselves on a co-operative basis. This is being done in several different forms according to the special needs of each type of industry, but the general characteristic is that the knowledge, ability and other services formerly embodied in the middlemen are being taken over by some kind of centralizing agency, which manages in general a mechanized finishing factory, governed by a board. The board in turn is chosen by the workers.

This agency, owned and directed by the small-scale workers themselves, supervises a fair division of profits, the reservation of a sufficient amount of money for later expansion and for vocational training of new workers. It is a kind of 'new deal' organization, which has sprung up spontaneously in the Javanese society. The Government, and more specifically the Bureau of Industry, has promoted this movement for these last seven years, under my direction, in every possible way.

Apart from this small-scale industry, there was, during this time, a continuous development of the mechanized industry. In 1940 alone, more than five hundred new factories were established. The secondary industry quickly expanded. Practically the entire field of consumers' goods, from crockery to shoes and clothing, from vegetable fats to chocolates, from soap to rubber, were influenced by this innovation. Formerly the mechanized industry had always depended on the long established agriculture and mining industries, but since 1935 an independent commodity industry began to arise.

The Government thus had to meet the demand for leaders, skilled labourers and technical instruction. First of all, consultation offices were established in the main centres. These offices had at their disposal a large staff of technical and economic instructors and also a staff of travelling vocational teachers, backed by well-equipped central research stations and laboratories. In 1940, 332 industrial schools, with Indonesian languages as their medium, and 379 with Dutch as their language, 26 technical commercial schools with Indonesian languages and 4 with Dutch, were in existence. In addition to the textile research institutions, the ceramic research works and the leather laboratory, there were also vocational schools for specialized engineers to help in large factories, or to establish themselves as leaders of smaller units. Small and very simple schools were established all over Java to educate skilled labourers for the textile, pottery, tanning and other industries. Travelling vocational teachers were also of inestimable value to the small-scale workers. Practically all these instructors, all these travelling and vocational school teachers, were Indonesians. Care also has been taken, however, to establish colleges for the education of factory leaders. In the beginning the University at Bandoeng only turned out civil engineers, but the faculty soon had to be enlarged in order to produce mechanical, technological and electrical engineers. The majority of the students were Indonesians. But a young industry is not the right place to gain general experience. Scholarships, therefore, were extended to young Indonesian graduates of the University, which would enable them to gain experience abroad. In this way, the Government hoped to create Indonesian industrialists.

Large factories also came into existence. Persons well trained for research and with wide experience are rare in the Netherlands East Indies. To meet these difficulties all these large factories are formed as affiliated enterprises of well-established factories abroad. In this way, they can profit by the research work and experience of the mother industry, and every development abroad is available with a minimum of cost.

The future of the Netherlands East Indies industry lies in the production of consumer goods, as the iron ores found in the Netherlands East Indies are poor and the coal is very soft. Because of this, heavy industry, based on iron, is practically impossible. Though we produce a large quantity of tin, this metal will continue, therefore, to remain an export product. The case is different regarding bauxite. Large masses of rich ores are available, and in the vicinity of the mines huge water-power plants can be installed. The construction of an aluminium factory had already started when the Japanese invaded Sumatra. Other metal ores found in the Netherlands East Indies, perhaps with the exception of nickel, are all poor in quality or in quantity.

On the other hand, raw materials such as rubber, sisal, wood and fibres for paper and rayon, vegetable oils, salt, tannery barks, can be had in any quantity. (Salt and sulphur as bases for chemical industries are available. Cow-hides, fish and fruits can serve as the foundation for further industry.) Water-power, coal and natural gas are readily available, and the Javanese is a good labourer, as long as he does not have to handle too much weight. As a spinner and weaver, for example, he is an excellent worker, but in the rolling mill he would lack the desired qualities.

OBITUARIES

Mr. Robert W. Paul

THE announcement of the death on March 28 of Mr. Robert W. Paul will recall to many the great part he played in the manufacture of electrical measuring instruments and the development of the cinematograph.

R. W. Paul was born at Highbury, London, in 1869 and was educated at the City of London School and at the City and Guilds Technical College, Finsbury. He worked in the electrical instrument shop of Messrs. Elliott Brothers and obtained there a practical knowledge of instrument making which was invaluable to him. In 1891 he started business for himself as an instrument maker in Hatton Garden, working long hours and using his inventive powers in perfecting the small, but important, parts of electrical instruments. He was fortunate in being able to work under the inspiration of such pioneers of electrical measurement work as Perry, Ayrton and Mather. It was on the manufacture of instruments developed with these pioneers that Paul built up a successful business.

In 1903 Paul invented a moving-coil galvanometer in which the coil is supported on a single pivot resting on a jewel, placed in the centre of a steel ball which is fixed between the poles of a permanent magnet. He gave the instrument the eminently suitable name of 'Unipivot' and it met with an immediate success. The first model gave a full deflexion for about 60 micro-amperes (coil resistance 50 ohms), a sensitivity far beyond that of any pivoted galvanometer then in existence. The 'Unipivot' maintained this proud pre-eminence for many years. Realizing the small amount of energy required to actuate it, he developed a series of resistances, shunts, etc., which made it an invaluable instrument for laboratory and test-room work. He fitted an efficient locking device which held the coil with its pivot away from the jewel, thus rendering it safe for transit. He was fond of demonstrating the robustness of the instrument and the efficiency of the clamping device by throwing it in its leather case downstairs, or even using it as a football.

In 1900 Paul transferred his works to Muswell Hill and it was there that the majority of his instruments were made.

About 1907 he commenced to make instruments designed by Albert Campbell for alternating current work, a collaboration that was most fruitful in producing instruments which have stood the test of time in a remarkable manner.

Paul's fame as an inventor will probably rest on the cinematograph rather than on his instruments. He was the first maker in Great Britain of a projector for showing pictures continuously, and his mechanism for feeding forward the film intermittently, generally referred to as the 'Maltese cross', is still universally used. The story is well known of the excitement caused in Hatton Garden when the first picture was shown in his workshop. The first semi-public display was given at the Finsbury Technical College in February 1896. He went to immense trouble to make and take pictures. In June 1896, he photographed "Persimmon" winning the Derby and projected it himself the same evening at the Alhambra. The excitement of the audience was intense, and it is said that Paul was called before the curtain six times. He fully realized the possibilities of the cinematograph for scientific work. In conjunction with Prof. Silvanus Thompson and a group of students, a series of diagrams were drawn showing changes in some phenomenon, for example, in the field between two magnets as they approached each other. These various diagrams, or pictures, were photographed separately and then projected continuously in the accepted manner of a Walt Disney film. About 1912 he disposed of his cinematograph rights and no longer interested himself in the industry.

In 1920 his business was amalgamated with the Cambridge Scientific Instrument Company, the combined firms now being known as the Cambridge Instrument Company Limited.

During recent years he developed, with Sir William Bragg, the Bragg-Paul pulsator, an apparatus for assisting breathing in cases of respiratory paralysis. He had the satisfaction of knowing that this apparatus had been instrumental in saving the lives of several children.

The scientific instrument making industry owes much to Paul's efforts to improve the technical education given to its workers. He advocated, and indeed put into practice in his own works, the holding of technical and theoretical classes for the training of apprentices in the works. He showed his further interest by founding the Paul Scholarship, which is administered by the Institution of Electrical Engineers, for enabling young students to enter the works of a scientific instrument firm for two years training.

Paul interested himself in several societies and served on the councils or boards of the Institution of Electrical Engineers, the Institute of Physics and the Physical Society. He acted as treasurer of the last-named Society during 1935–38 and as vice-president during 1939–42. He had also served the Royal Institution as a manager and a vice-president. He was awarded the sixteenth Duddell Medal by the Physical Society in 1938.

Mention should be made of the admirable collection of electrical instruments that he assembled at the Royal Albert Hall in 1931 for the Faraday Centenary Exhibition. Many of the exhibits were constructed under his direction, several with his own hands.

In his prime, Paul had immense energy and a great capacity for getting things done. With it all, he had a dry sense of humour and an attractive personality. The wreath sent by the Cinema Veterans 1903 Society for his funeral was inscribed: "The first Englishman to produce and exhibit a Cinematograph Film".

R. S. WHIPPLE.

WE regret to announce the following deaths:

Dr. Edgar Allen, professor of anatomy at Yale University School of Medicine, aged fifty.

Prof. A. A. Boon, emeritus professor of chemistry at Heriot-Watt College, Edinburgh, on April 2, aged seventy-six.

Prof. Gary N. Calkins, emeritus professor of protozoology in Columbia University, on January 4, aged seventy-three.

Lieut.-Colonel E. Kitson Clark, president during 1931–32 of the Institution of Mechanical Engineers, and during 1921–22 of the Institution of Locomotive Engineers, on April 15, aged seventy-six.

Dr. Albert Hassall, bibliographer and formerly assistant chief of the Zoological Division, U.S. Bureau of Animal Industry, on September 18, aged eighty-one.

Dr. J. E. Ives, for many years physicist to the United States Public Health Service, aged seventy-seven.

Prof. A. Lloyd James, University professor of phonetics, School of Oriental and African Studies, London, aged fifty-eight.

Prof. Heinrich Zwicky, professor of veterinary medicine at the Zurich faculty of veterinary medicine.

NEWS and VIEWS

Mr. P. I. Dee, F.R.S.

MR. P. I. DEE, whose appointment to the chair of natural philosophy at the University of Glasgow was announced in NATURE of April 17, has for the past twenty years been one of the most outstanding of the younger physicists at Cambridge; first as student, then as teacher and research worker. From Marling School, Stroud, Mr. Dee entered Sidney Sussex College in 1922 as entrance exhibitioner. In 1925 he obtained a first class in Part I of the Natural Sciences Tripos and was elected scholar of his College. In the following year he gained a first in physics in Part II of the Tripos, was elected research scholar at Sidney and started work under Prof. C. T. R. Wilson at the Solar Physics Observatory. For several years after this, Mr. Dee's work continued to be mainly on the Wilson cloud chamber, and it gained him in 1928 a Taylor research fellowship (at Sidney) and in 1930 the Stokes studentship, which required his emigration to Pembroke. On the expiry of his tenure of this studentship in 1934, his own College reclaimed him with the award of a full fellowship (without teaching duties). Meanwhile, the University of Cambridge had appointed him demonstrator and then lecturer in the Cavendish Laboratory. Here, for a period, he was responsible for the teaching in the advanced practical class, and in 1937 he took over the organization of research in the High Voltage Laboratory, in which, at the outbreak of the War, he had just succeeded in bringing the second (2-million volt) Philips set into operation. When this set comes to be re-assembled and work restarted, when the War ends, his colleagues at Cambridge will miss his leadership more than brief words can convey. Mr. Dee was elected to the Royal Society's fellowship in 1941.

Prof. C. A. Elvehjem

THE thirty-second Willard Gibbs Medal, the highest award of international scope which the Chicago Section of the American Chemical Society can bestow, has been given to Prof. C. A. Elvehjem, professor of biochemistry in the University of Wisconsin. In 1928, Prof. Elvehjem with his associates received wide recognition for work involving trace elements in nutrition. They discovered that copper is essential to the formation of hæmoglobin. Later their studies revealed the place of a number of metals in nutrition, such as iron, manganese and aluminium. While at Cambridge, Prof. Elvehjem conducted studies on tissue respiration which have since been applied to the study of vitamin functions. Use of nicotinic acid in the prevention and cure of pellagra and other deficiency diseases have developed from Prof. Elvehjem's discovery. The role of nicotinic acid in animal nutrition has also been developed. He is now conducting studies on the newer members of the growing family of B vitamins.

Institute of Fuel: New President

DR. E. W. SMITH has been elected president of the Institute of Fuel for the session 1943–44, and will take office in October next. Dr. Smith has been well known in the fuel world for many years, having been chief chemist at the Birmingham Corporation Gas Department for several years before becoming technical director of the Woodall-Duckham Companies some twenty years ago. In 1941 he was appointed by Sir Andrew Duncan, then president of the Board of Trade, as director-general of gas supply in Great Britain, a position he continued to hold when the Government interests in the gas industry were transferred to the new Ministry of Fuel and Power. Having completed the work for the Government that he had undertaken to do, he resigned his position a few weeks ago.

Bicentenary of Dr. Edmund Cartwright

April 24 marks the bicentenary of the birth of Rev. Edmund Cartwright, who by his invention of the power-worked loom made a notable contribution to the progress of cotton manufacture. A descendant of a family long established at Marnham, Nottinghamshire, he was educated at Wakefield Grammar School and University College, Oxford, took holy orders, and married a lady of wealth. His first appointment was to the perpetual curacy of Brampton, Yorkshire, but in 1779 he was made rector of Goadby Marwood, Leicestershire. His interests at this time were mainly connected with agriculture and poetry, but a visit to Matlock in 1784 changed the current of his life. At that time the work of Paul, Hargreaves, Arkwright and Crompton had placed the spinners far ahead of the weavers, and at Matlock, Cartwright was present at a conversation when mechanical weaving was declared an impossibility. His latent powers of invention were aroused, and at Goadby Marwood, with the assistance of the local craftsmen, he made a crude loom in which the necessary movements were all made by mechanical power.

In the following year, 1785, Cartwright secured the first of his three patents in connexion with weaving. He next opened a weaving mill at Doncaster, and there made inventions in wool combing and another for rope-making. This last, an outstanding and basic invention, was the 'Cordelier', which soon became part of everyday practice. Unfortunately, the mill was not a financial success, and by 1793 Cartwright had spent a fortune of £30,000 and had got into debt. Recording his feelings in a stoical sonnet, he left Doncaster for London and about 1800 entered the service of the Duke of Bedford at Woburn, and much of his later life was devoted to agriculture. His looms, much improved by other mechanics, gradually came into use, and in 1809 the Government was prevailed upon to award him a sum of £10,000, a part of which Cartwright used to buy a farm at Hollander, between Sevenoaks and Tonbridge. His death took place at Hastings on October 30, 1823, by which time there were probably more than twenty thousand power looms in England and Scotland. He is buried at Battle, Sussex, where a tablet to him was placed in the church.

William Wallace (1768–1843)

A century ago, on April 28, 1843, William Wallace, the Scottish mathematician and astronomer, died at the age of seventy-four. Born at Dysart, on September 23, 1768, Wallace began life as a bookbinder's apprentice, but by private study and the assistance of Robison, Playfair and others gained a sound knowledge of mathematics, and at the age of twenty-six became an assistant master in Perth Academy. Nine years later, in 1803, he became an instructor at the Royal Military College, then housed at Great Marlow. In 1819 he was chosen to succeed Leslie as professor of mathematics at the University of Edinburgh, and he held this post until seventy years of age. On retirement he was awarded a Civil List pension of £300. He had many interests, wrote much for the "Encyclopædia Britannica", contributed to the Royal Astronomical Society and other bodies, and it was largely through his efforts that the small private observatory on Calton Hill, Edinburgh, was improved, the observatory being taken over by the Crown in 1834 when Thomas Henderson became the first Astronomer Royal for Scotland.

Society of Fellows Foundation at Harvard

It is announced in the *New York Herald Tribune* that the Society of Fellows Foundation at Harvard University, which was established by the late Dr. A. Lawrence Lowell, president of Harvard from 1909 until 1933, was also endowed by him with a fund of 2,000,000 dollars. Dr. Lowell made the gift anonymously, directing that his name was not to be divulged until after his death, when the fund was to be named after his wife, Anna Parker Lowell. By the terms of the Foundation, the principal of the fund is kept intact and the income used to enable a small number of men selected for their promise of making notable contributions to knowledge to devote their whole time to productive scholarship. The selected men are known as 'junior fellows' and receive tuition and accommodation privileges and 1,250–1,500 dollars a year. By this announcement, it is known that Harvard is indebted to Dr. Lowell not only for much of its present reputation and indirectly for its separate colleges, but also for its well-known fellowships. Dr. Lowell died on January 6, aged eighty-six (see Nature, Feb. 13, p. 190).

Rock Paintings in Southern Rhodesia

In a paper before the Rhodesia Scientific Association, Mr. L. Cripps has again directed attention to the rock-shelter paintings of Southern Rhodesia (*Proc. Rhodesia Sci. Assoc.*, 39 ; 1942). There is still much to be done, and soon, if these paintings are to be preserved, or at least properly studied before their almost inevitable destruction follows on the more intensive opening up of the country. Incidentally, Mr. Cripps mentions the well-known site in the N'danga-Victoria district, where the so-called Egyptian figures occur. Dr. Impey, who first described the site, likened them to certain predynastic Egyptian paintings, and this equation is now assumed by a number of prehistorians. Attention might be directed, however, to some rock-shelter paintings from Ido in the Fezzan district south of Tripoli, North Africa, where very similar painted figures occur. They are reproduced (Plate lxxxi) in Leo Frobenius's recent publication "Ekade Ektob, die Felsbilder Fezzans", 1937. Perhaps for the present it would be wiser to equate the N'danga paintings with counterparts in North Africa rather than to suggest that they owe their origin to predynastic Egyptians penetrating as immigrants southwards to Rhodesia.

Seismological Tables

A set of seismological tables by Dr. H. Jeffreys and Dr. K. E. Bullen dated 1940 and published by the British Association for the Advancement of Science from its offices at Burlington House, London, W.1, has just been received. The tables are published with the assistance of a grant from the Gray Milne Trust. They have all been published previously by the Royal Astronomical Society and are reproduced in the booklet above mentioned in collected form.

LETTERS TO THE EDITORS

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

Ascorbic Acid in Mashed Potatoes

ALTHOUGH it might be expected that the mashing of potatoes, with the intimate distribution of air throughout the heated vegetable which it involves, would cause considerable oxidation of ascorbic acid, little information on the matter seems to be available.

Experiments were therefore carried out: (1) to determine the loss incurred when potatoes were mashed and served immediately after mashing; (2) to compare the rate of destruction of ascorbic acid when mashed and whole potatoes were kept hot; (3) to compare the effect of keeping whole and mashed potatoes hot in bulk and in small helpings.

A thoroughly representative sample of about 900 gm. of medium-sized potatoes, boiled whole, was taken and one half was mashed and immediately sampled. The whole and the mashed potatoes were then weighed and, except for one small helping kept at room temperature, were kept hot in a water-heated double pan for more than two hours, at a temperature of 80–85° C., samples being removed periodically for estimation of ascorbic acid by titration against 2 : 6 dichlorphenol-indophenol. The remainder were weighed after the last sample had been taken to enable allowances to be made for the loss in weight due to evaporation during heating. This loss was too small to be significant, however.

TABLE 1.

ASCORBIC ACID IN WHOLE AND MASHED POTATOES KEPT HOT.

Description	Kept hot	Ascorbic acid mgm./100 gm.
Boiled	0 min.	5·4
	20 ,,	4·0
	60 ,,	2·5
	135 ,,	0·9
Boiled, then mashed	0 min.	5·0
	20 ,,	1·8
	30 ,,	0·5
	135 ,,	0·4
Whole, kept at room temperature	0 min.	5·4
	135 ,,	4·3

The results of the experiment are shown in Table 1. It is clear that mashing small quantities of potatoes has no immediate effect on their ascorbic acid content, but the rate of loss during subsequent heating is considerably accelerated.

The table also shows that while standing at room temperature cooked whole potatoes lose but a small proportion of their ascorbic acid. This supports the suggestion of Dienst[1] that it is preferable to allow vegetables to cool and to reheat them when necessary rather than to keep them hot. In another experiment, not quoted in the table, it was found that during three hours standing, even at room temperature, mashed potatoes lost more ascorbic acid than did whole potatoes.

TABLE 2.

Description	Ascorbic acid, mgm./100 gm.
Potatoes, whole after cooking	4·7, 4·5 (mean 4·6)
,, immediately after mashing	4·0, 4·0 (mean 4·0)

	Kept hot	Kept hot in bulk	Kept hot in individual helpings
Potatoes, whole	30 min.	4·9	—
	60 ,,	4·1	3·8
,, mashed	30 ,,	2·4	3·0
	60 ,,	0·9	1·0
Cabbage	0 min.	12·0	12·0
,,	60 ,,	5·6	4·2

Table 2 shows the effect of a similar experiment carried out with the kind co-operation of Messrs. Barkers, Ltd., under large-scale catering conditions at their canteen at Messrs. Sebro Ltd. The effect of keeping vegetables hot in bulk and in small helpings was studied simultaneously. The result confirmed the conclusions previously reached in the laboratory on the effect of mashing. The difference between vegetables kept hot in small portions and in bulk is variable; mashed potatoes lost more in bulk, while cabbage and whole potatoes incurred greater oxidation in separate helpings in this experiment. Other experiments have given variable results, but the magnitude of the differences has always been small, so that it appears not to matter whether the vegetables are served up or left in bulk during the time they are kept hot. This result agrees with that previously found by Dienst[1].

It was found that if the mashing of the potatoes took more than a short time, a loss might occur during the process. For example, when a large batch was mashed by hand the time occupied was ten minutes, and the ascorbic acid fell from 10·5 mgm. to 6·9 mgm. per 100 gm.

The significance of these results is clear. If potatoes are to be kept hot for some time before serving, as seems inevitable under many conditions of communal feeding, they should not be mashed; nor should they be mashed unless the process can be completed within two or three minutes. There seems to be little difference in ascorbic acid content between vegetables kept hot in bulk and in small helpings.

I wish to express my thanks to Dr. L. J. Harris for helpful advice and hospitality at the Dunn Nutritional Laboratory where this work was carried out.

G. N. JENKINS.

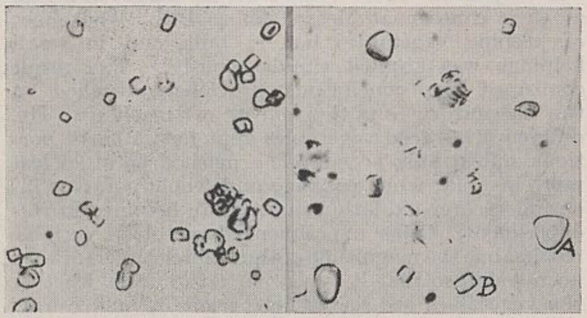
Dept. of Physiology,
St. Bartholomew's Medical College,
c/o Dept. of Zoology,
Cambridge.

[1] Dienst, C., *Deutsch. Med. Wochenschr.* (Cologne), 68, 400 (1942).

Pure Crystalline Rennin

NORTHROP[1] has shown that crystallization is a useful procedure in the purification of certain enzymes. Crystalline form, however, is not reliable evidence of purity, as pointed out, for example, by Pirie[2], but may be considered as confirmatory evidence. For these reasons, in a recent attempt in this laboratory to obtain pure rennin, conditions favouring crystallization have been chosen. A preparation consisting largely of flat crystalline plates but containing a small proportion of spheroids has been obtained. From the accompanying photomicrographs it can be seen that although the outline of the plates is irregular, it tends to be triangular or rectangular, that the bounding surfaces are plane, and that the small surfaces forming the 'edges' of the plates are at right angles to the main surfaces. The latter conclusion arises from the rectangular appearance of the plates when seen 'on edge'.

A preliminary experiment has shown that the solubility of this preparation is independent of the amount of solid phase present, whether judged by the activity or by the amount of nitrogen in the solution. Thus it may be assumed, subject to confirmation by more extensive experiments, that no major impurity is present. Northrop[1] found that less than 1 per cent of mucin prevented the crystallization of pepsin, and it seems probable that a similarly small quantity of impurity is the cause of the imperfection of these rennin crystals.



1 2

1, Rennin Crystals; 2, Rennin Crystals, *A*, view of a surface, *B*, view of an 'edge'.

The following is a brief outline of the method of preparation; a fuller description will be published elsewhere. Commercial rennet, equivalent to about 80 litres of the usual cheese-making rennet, was precipitated by saturation with sodium chloride at *p*H 5·4. After solution and re-precipitation, the rennin was adsorbed on to alumina formed *in situ* from potash alum. The process of salting out and re-solution was then repeated several times. At this stage the slow addition of saturated magnesium sulphate caused the precipitation of spindle-shaped masses which could be mistaken for crystals. A closer examination, however, showed them to consist of aggregates of minute spheres held together in a transparent matrix of mucin. The removal of most of the mucin by fractional precipitation prevented the formation of these aggregates and allowed the growth of larger spheroids. Numerous repeated fractional crystallizations, by the slow addition of saturated magnesium sulphate, led eventually to the preparation shown above.

The crystals contain 13 per cent Kjeldahl nitrogen, are more soluble in cold salt solutions than in warm, and are able to clot in 10 minutes at 37° C. approximately 10^7 times their dry ash-free weight of reconstituted milk made by dissolving 12 gm. spray-dried skim milk powder in 100 ml. $N/50$ calcium chloride solution.

N. J. BERRIDGE.
National Institute for Research in Dairying,
University of Reading.

[1] Northrop, J. H., "Crystalline Enzymes" (Columbia University Press, New York, 1939).
[2] Pirie, N. W., *Biol. Rev.*, 15, 377 (1940).

An Optically Active Arsonium Salt

SEVERAL attempts have been made in the past to synthesize an arsonium salt of type $[R^1R^2R^3R^4As]X$ (where X represents a monovalent acid radical), and then to resolve the salt into optically active forms by virtue of the asymmetric arsenic atom it contains. The synthesis of such compounds is not difficult, but the separation of the racemic salt into optically stable *dextro* and *lævo* modifications has not hitherto been achieved.

Burrows and Turner[1] prepared phenyl-α-naphthyl-benzyl-methyl arsonium bromide, converted this salt into the corresponding *d*-bromcamphor-sulphonate, and separated the latter by recrystallization into two fractions having $[M]_D = +281°$ and $+300°$ respectively. The latter fraction was then converted into the arsonium iodide, which proved to have a fleeting rotation, and the highest value measured was $[M]_D = +12°$.

Kamai[2] prepared *p*-tolyl-benzyl-ethyl-*n*-propyl arsonium iodide, converted it into the *d*-bromcamphor-sulphonate, and separated the latter similarly into three fractions having $[M]_D = +318°$, 291°, and 285° respectively. The first fraction was converted into an (unanalysed) iodide having $[M]_D = +45°$, which rapidly racemized in solution: the other two fractions gave inactive iodides.

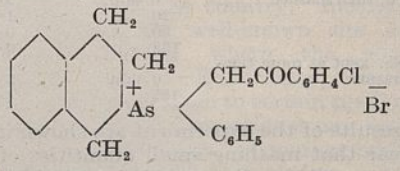
Burrows and Turner (*loc. cit.*) have obtained evidence that some quaternary arsonium salts undergo partial dissociation in solution to give a tertiary arsine and an alkyl halide, which remain in equilibrium with the undissociated salt:

$$[R^1R^2R^3R^4As]X \rightleftarrows R^1R^2R^3As + R^4X.$$

They suggest that the rapid racemization of their *dextro*-arsonium iodide was due to the formation of such an equilibrium.

The accuracy of this suggestion, as a general explanation of the difficulty of isolating optically stable arsonium salts, could be tested by investigating either an arsonium salt having four unlike *aryl* groups attached to the arsenic atom, in which case the above dissociation would be exceedingly unlikely, or an arsonium salt which for some other reason possessed very high stability.

We have recently been investigating the synthesis and therapeutic action of various tetrahydro-*iso*-arsinolines[3]. These compounds appeared to us to afford a ready method by which Burrows and Turner's suggestion could be tested. In another investigation, the great stability of *p*-chlorophenacyl compounds compared with that of the corresponding unsubstituted phenacyl compounds had been manifest. We therefore combined 2-phenyl-1 : 2 : 3 : 4-tetrahydro-*iso*-arsinoline with *p*-chlorophenacyl bromide to give the salt, 2-*p*-chlorophenacyl-2-phenyl-1 : 2 : 3 : 4-tetrahydro-*iso*-arsinolinium bromide (I):

(I) 

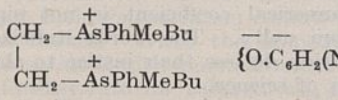
As anticipated, the arsonium ion in this compound appeared to have great stability. The bromide was converted into the *d*-camphor sulphonate, which, however, on recrystallization showed no evidence of optical resolution. The *d*-bromcamphor sulphonate of the arsonium ion, which when isolated had $[M]_D = +279°$ in chloroform solution, was, however, readily separated by recrystallization from alcohol into a less soluble and optically pure fraction having $[M]_D = -140°$, and a more soluble (but not quite optically pure) fraction having $[M]_D = +575°$: neither fraction showed any change of rotation in chloroform solution at room temperature.

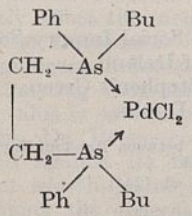
The less soluble fraction, which clearly consisted of the *l*-arsonium-*d*-bromcamphor sulphonate, was converted into the picrate, having $[M]_D = -450°$ in chloroform and $-337°$ in acetone: no racemization in either solvent could be detected. This picrate, treated with potassium iodide in ice-cold aqueous acetone, deposited the crystalline iodide, which in chloroform solution had $[M]_D = -326°$. This conversion of the picrate to the iodide was evidently accompanied by slight racemization, since recrystallization from alcohol gave the optically pure iodide, having $[M]_D = -354°$, unchanged by further recrystallization. We have yet to determine whether this slight racemization occurs during the actual conversion of the picrate to the iodide, or during the period in which the iodide remains dissolved in the acetone before crystallizing out: it is significant, however, that the iodide is optically stable both in cold chloroform and in hot alcohol.

The original racemic bromide was similarly converted into the *l*-bromcamphor sulphonate, which on recrystallization gave a less soluble fraction having $[M]_D = +140°$, which in turn furnished a picrate having $[M]_D = +457°$, both in chloroform solution.

We consider that these results afford strong confirmation of the views of Burrows and Turner. Clearly, dissociation of the above arsonium bromcamphor sulphonates and picrates is for chemical reasons almost impossible: the iodide could possibly dissociate into the original tertiary arsine and *p*-chlorophenacyl iodide, but the great stability of the arsonium ion would make such dissociation very small indeed.

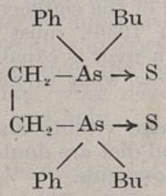
Chatt and Mann separated both ethylene-αβ-bis(phenyl-methyl-*n*-butyl-arsonium picrate[4]) (II) and the dichloro-palladium compound[5] (III) into two isomeric forms, one of which in each case must have

(II) 

(III) 

been the *meso* and one the racemic form. It is noteworthy that in neither case could either form be converted into the other even in boiling organic solvents. These results also are clearly in harmony with Burrows and Turner's suggestion. Dissociation of the picrate (II) could occur only by the formation of the ditertiary arsine and an alkyl picryl ether, which is chemically extremely unlikely: dissociation of the palladium compound (III) is prevented by the great stability of the cyclic co-ordinated system.

There is at present little evidence concerning the precise factors which determine the configurational stability of non-ionic 4-covalent arsenic compounds such as the tertiary arsine sulphides. Chatt and Mann (*loc. cit.*) separated ethylene-αβ-bis(phenyl-*n*-butyl-arsine sulphide) (IV) into two isomeric forms, one of which again must have been the *meso* and the

(IV) 

other the racemic form. In this case, the lower melting form very readily passed over to the higher melting form, a conversion which must have involved a change of configuration of one of the arsenic atoms. On the other hand, Mills and Raper[6] showed that the *dextro* and *lævo* forms of methyl-ethyl-*p*-carboxyphenyl-arsine sulphide which they isolated possessed considerable stability, and no racemization of these compounds has been recorded.

It is possible that in these arsine sulphides, racemization is similarly dependent on partial dissociation to tertiary arsine and sulphur, and will therefore be dependent in turn on the chemical stability of the particular compound investigated. Certainly, however, no evidence of such dissociation in solution was detected in Chatt and Mann's bis-arsine sulphide.

F. G. MANN.
F. G. HOLLIMAN.
University Chemical Laboratory,
Cambridge. March 27.

[1] *J. Chem. Soc.*, **119**, 426 (1921).
[2] *Berichte*, **66**, 1779 (1933).
[3] NATURE, **150**, 603 (1942).
[4] *J. Chem. Soc.*, 610 (1939).
[5] *J. Chem. Soc.*, 1622 (1939).
[6] *J. Chem. Soc.*, **127**, 2479 (1925).

Town-Planning and the Small Sewage Purification Plant

IN the percolating filter system of sewage purification, at any one works a more or less constant supply of fine solids and nutritive substances in solution is fed to the filters, and from these is built up a composite growth that tends to choke the passage. The growth is counteracted by scouring organisms, usually of varied type, but including in particular enchytræid worms and the larvæ of flies. In the main, strength of sewage determines the composition of the fauna, and the season of the year determines what forms will be dominant for the time being. Reynoldson has recently shown that obstruction and ponding occur when the fauna is restricted to one dominant form[1,2]. A balanced fauna is most efficient as covering all seasons of the year, with some restriction of any one species through the effects of competition[3]. The operator at present has no control over the composition of the scouring fauna. It follows that if there are more worms there will be fewer flies, and vice versa. The fact that there must be a large output of flies makes it very undesirable that percolating filters should be close to dwellings. For though the flies are not in that dangerous class particularly attracted to human foods, it must be remembered that they originate from highly contaminated places, that they are mostly inconspicuous and that they may fall into milk and foods. No instances of ill-health, however, have yet been traced to them, except in so far as worry is a cause of illness. Proof of direct association with disease might be impossible.

During the past two years, my attention has been directed to an undesirable state of affairs in a small town which lies in the midst of a dense cluster of independent industrial townships each apparently treating its own sewage in small units. A housing estate has been allowed to approach two sides of the works in question, and the neighbouring town has similarly built up almost to the bank of a small stream that forms a third boundary. For some years there have been complaints of sewage flies entering the dwellings. The insect that causes most concern is the rather conspicuous fly, *Anisopus fenestralis*, which as the name indicates is prone to enter houses. It is not one of the commonest sewage flies, though I know of its establishment at three widely separate sewage works. Through ten years I have not taken it in the Leeds beds, though the insect is otherwise fairly common in the district. In the spot under consideration there are complaints that it has turned up in bread, and the medical officer of health showed me a fly paper that had been exposed in a small shop and was so densely covered with Anisopus (no other fly present) that it could have held few more. In another locality it is said to oviposit on such things as dish-cloths and green salads.

The information gathered was that the insect became common some eight years ago at about the time when an extensive system of sedimentation tanks was abandoned in favour of a single small patent tank. About this time, apparently, the springtail insect (*Achorutes viaticus* probably) which had been very common disappeared, and this fly made its appearance. My conclusion was that too much solid was being fed to the beds, as each piece of clinker was capped by a heap of slimy débris which was a wriggling mass of enchytræid and nematode worms, while a few inches down in the medium was an almost continuous layer of developing Psychoda and Anisopus flies. The final effluent, however, was good and settled quickly, satisfying the Rivers Board. Far removed from dwellings there would have been no real fault to find.

Chemical control of the flies was not desirable as such could not be selective, and any depletion of the fauna would have been followed by choking of the beds and ponding. It could not be certain that drastic reduction of the solids would lead to the disappearance of the established pest, and therefore an experimental approach was suggested by reducing the solids fed to one filter and subjecting another to double filtration to obtain a cleaner medium. Thus it could be found whether modification of the existing system would be justified, but it was pointed out that there must always be a lot of flies about bacteria beds and the only radical cure was substitution of an activated sludge system.

The matter is brought to light because it forms such an excellent illustration of the shortcomings of the small unit in sewage purification in congested areas. The system is most costly to set up, and once set up the local authorities are naturally reluctant to make a change. Ignorance or the cost of land often brings the works too near the town. It is not possible to provide the requisite scientific supervisor with laboratory facilities. Too often the small unit is in charge of a foreman under the supervision of an official who has many and varied duties and experience but not that very specialized knowledge required in sewage purification ; engineering, chemistry, bacteriology and biology being all involved. Also since the best system is very wasteful, the research instinct is desirable so that economies can be sought[4]. In a sound system of town planning these small units should be grouped into big undertakings, as has been done with so much success at Mogden. Numerous nuisances are thus removed and economies such as the recovery of fuel gas can be effected. Especially space can be afforded so that odours, and flies when the system is by percolating filters, can be dispersed without annoyance and possible danger.

Department of Zoology, University, Leeds.
LL. LLOYD.

[1] Reynoldson, T. B., *J. and Proc. Inst. Sewage Purification*, 109 (1941).
[2] Reynoldson, T. B., *J. and Proc. Inst. Sewage Purification* (in the press)
[3] Lloyd, Ll. Graham, J. F., and Reynoldson, T. B., *Ann. App. Biol.*, **27**, 122 (1940).
[4] Wishart, J. M., *Surveyor*, **95**, 283 (1939).

Accuracy of Boyle's Original Observations on the Pressure and Volume of a Gas

THE following statement occurs in the Dictionary of National Biography, 2 (1908), in regard to Robert Boyle's famous law: "This approximately true principle, *although but loosely demonstrated*, was at once generalized and accepted, and was confirmed by Mariotte in 1676" [italics mine]. From this I hoped to find in Boyle's original observations a striking application of a statistical theory of error elimination from the mathematical expression of physical laws, on which he had been working[1]. On reference to the original paper[2] this hope was not realized, for the reason that Boyle's observations were so accurate and so conclusive as to render error elimination a work almost of supererogation. Though there are a few obvious printer's errors in the paper, the results are presented in a manner which is a model for workers in experimental science in any age.

Formal application of the theory of Boyle's first table of observations (p. 101) gave the equation

$$-\log P = 1{\cdot}00404 \log V + C,$$

where P and V are the pressure and the volume respectively, and C is a numerical constant. With only twenty-five pairs of observations it is evident that the numerical coefficient is not significantly different from unity. The words italicized in the above quotation do less than justice to the work of a great man of science.

R. C. GEARY.
Statistical and Social Inquiry Society of Ireland,
65 St. Stephen's Green,
Dublin.

[1] "Inherent Relations between Random Variables", *Proc. Roy. Irish Acad.*, **47**, A, 6, 63.
[2] "Works", **1**, 100 (fol. ed. 1744).

Human Vitality and Efficiency

IN 1919 the Carnegie Institution of Washington published a comprehensive report in which Prof. F. G. Benedict and his colleagues remarked that "it is indeed surprising that after 15 years' search for a nutritional level with man markedly different from that of the normal individual, such a level should not have been found in all the researches conducted by this and other laboratories".

It is worthy of note that the 'laboratory of war' has now revealed such a nutritional level: from Belgium, for example, there is news that in 1941 the normal intake of food had sunk from 2,850 calories a day to 950. This is comparable with the dietary standard of the poor of Munich, as recorded by Rumford at the end of the eighteenth century ; and, as I pointed out in 1936[1], must mean that the basal metabolism of a man is capable of being reduced to a level far below what physiologists have believed to be possible.

Data on human vitality and efficiency under prolonged restricted diet are doubtless being collected in the occupied countries.

A. F. DUFTON.
The King's Lodge,
Hunton Bridge, Herts.
March 21.

[1] Dufton, A. F., *Lancet*, **231**, 1535 (1936).

RESEARCH ITEMS

Inheritance of Infantile Paralysis

J. Addair and L. H. Snyder (*J. Heredity*, **33**, 307–309; 1942) have studied the geneological histories of 29 individuals showing paralytic poliomyelitis. These 29 cases are definitely genetically interrelated. The authors consider that the facts suggest the existence of an autosomal recessive gene for susceptibility. In place of finding one quarter of the children affected, only one in 5·5 has shown the disease. Unaffected children have shown no subclinical signs which could be interpreted as milder expressions of the same disease. It would therefore seem that the expression of the gene for susceptibility does not always occur; the penetrance appears to be 70 per cent.

Alcohol and Tuberculosis

In a recent paper (*Quart. J. Stud. Alcohol*, **3**, 176; 1942) Dr. Emil Bogen, director of research at the Olive View Sanatorium, California, maintains that the intake of alcoholic liquor is only indirectly affected by tuberculosis, while the pharmacological effects of alcohol are not diminished by the disease and the lethal action may be enhanced. Alcohol in sufficient concentration can kill the tubercle bacillus *in vitro*, but such concentration cannot be produced within the tissues. While the immoderate use of alcohol is associated with more advanced disease and a higher fatality-rate for tuberculosis, its moderate use may not greatly affect the incidence and course of the disease. The therapeutic administration of alcohol has no significant influence on tuberculous lesions. While admitting that the external use of alcohol may be of value in several phases of the fight against tuberculosis, Dr. Bogen concludes that the arguments for and against its internal use by a tuberculous patient are the same as those for and against its use among the general population, and the existence of the disease offers little additional support to either its supporters or opponents.

Wing Development in Aphids

A. F. Shull (*J. Exp. Zoo.*, **89**, 183–195; 1942) has shown that heat and light influence the production of winged or wingless individuals in the aphid *Macrosiphum solanifolii*. Continuous light applied to aphids, the previous offspring of which were all winged (produced in intermittent light), suppressed the wings in 50 per cent of the progeny in three days. High temperature (30°) caused the same effect in one day, while intermediate temperatures (29–26°) took a longer time to produce the same effect. It was found that if aphids have been treated for a long time with intermittent light, their reaction to continuous light was slower than those treated for a short time by intermittent light. Heat and light treatment together augment each other in effect. It is suggested that the product of some substance which inhibits wing development is influenced by both heat and light.

Effects of Leafhoppers on the Functions of Apple Foliage

In their paper entitled "The Effects of Leafhopper Feeding Injury on apparent Photosynthesis and Transpiration of Apple Leaves", G. E. Marshall, N. F. Childers and H. W. Brody point out that the object of their investigations is to study the effects of various degrees of injury of this kind (*J. Agric. Res.*, **65**, 265; 1942). They conclude that injury to apple leaves caused by several species of apple leafhoppers of the genus Typhlocyba, grape leafhoppers (Erythroneura) and the potato leafhopper (*Empoasca fabæ*) was accompanied by a more or less marked reduction in apparent photosynthesis and transpiration, especially the former. A given number of the Empoasca had a more detrimental effect on leaf metabolism than an equal number of the other leafhoppers mentioned. Cross-sections of infested leaves showed that the mesophyll-feeding types of leafhopper (that is, Erythroneura and Typhlocyba) removed the contents of the cells of the palisade parenchyma, while the spongy mesophyll cells were not significantly affected unless the leaf had been severely injured. The authors conclude that the metabolism of apple leaves may be reduced early in the growing season when the leafhopper population is moderately low. When this occurs, the capacity of the injured leaves to function in a normal way is permanently affected. It appears, therefore, that early control of these insects is an important procedure.

Heat Treatment of Potato Witches' Broom

At the annual general meeting of the American Philosophical Society during November 20–21, L. O. Kunkel read a paper on "Potato Witches' Broom Transmission by Dodder and Cure by Heat". The virus disease known as witches' broom of potato was taken to the periwinkle, *Vinca rosea*, by means of the parasite, *Cuscuta campestris*. Diseased periwinkles became stunted, assumed an upright habit of growth, and produced large numbers of secondary shoots bearing small chlorotic leaves and virescent flowers. They did not recover from the disease, but were readily cured by suitable exposures to high temperatures. The new growth produced by cured periwinkles was normal in every respect. Diseased potato plants were not cured by similar applications of heat, because they were unable to endure the treatments required to inactivate the virus; but diseased tubers endured virus-inactivating temperatures and were easily cured. When planted, they produced satisfactory yields. Recently a number of different viruses have been inactivated *in vivo* by subjecting plants to moderately high temperatures. Witches' broom is the first potato virus disease for which heat is a satisfactory curative measure.

Physiology of the Grass Seedling

The degree of the inhibition of the mesocotyl of *Avena sativa* by continuous exposure to light of low intensities in narrow bands in seven different parts of the spectrum is examined by R. L. Weintraub and E. D. McAlister (Smithsonian Misc. Coll., **101**, No. 17; 1942). The inhibitory effect is produced over a relatively great range, from 4,305 A. to 7,700 A., and in all the effective bands the inhibition is proportional to the logarithm of the light intensity. For each wave-length there appears to be a definite threshold value, suggesting that cell multiplication is inhibited at low intensities but that the inhibition of cell elongation is also involved at higher intensities. Whether expressed on an energy or a quantum basis, inhibition is greatest at about 6,600 A., with the indication of a second peak at about 6,200 A. The authors suggest that these maxima may be correlated with the absorption bands with maxima at about

625 mμ and 660 mμ observed in extracts of etiolated oat seedlings. The reaction to light of both mesocotyl and 'top' is actually and relatively greater in maize seedlings grown in a nutrient solution than in seedlings grown in distilled water (J. H. Kempton, *J. Washington Acad. Sci.*, **32**, No. 11 ; 1942). The roots do not appear to be appreciably affected by the culture solution, or by the light exposure given to the tops. The quantity of dry matter translocated is greater in the seedlings in the nutrient solution and, in conformity with this, at the end of about five days there is less residual material in their grains. Exposure to 100 foot-candle-hours of Mazda light does not affect the total amount of dry matter translocated, but even this brief period of illumination increases the dry matter in the coleoptile and enclosed leaves and reduces that in the mesocotyl, suggesting that the light initiates or speeds up the development of the leaves. The loss in dry weight of the germinating seedling is about equal to the dry weight translocated.

Freezing-Points of Solutions of Typical Colloidal Electrolytes

Conductivity alone is an untrustworthy guide in many cases as to whether or not a particular solution is that of a colloidal electrolyte. In all such cases it is essential to adduce other physical chemical evidence. As the most conclusive is the direct comparison of thermodynamic with electrical properties, S. A. Johnston and J. W. McBain have made careful freezing-point determinations for a number of colloidal electrolytes (*Proc. Roy. Soc.*, A, **181**, 119 ; 1942). It is shown that the behaviour of different groups in solution falls into several different types, although all have in common the replacement of ions by colloidal particles with increase in concentration. For example, in the family of bile salts, as in those of certain wetting agents, the conductivity almost approaches the behaviour of an ordinary electrolyte, whereas the lowering of freezing-point falls off strongly and rather abruptly. It is pointed out that the term 'critical concentration' of micelles, as often used, is either an over-simplification or a misconception. Micelles are actually formed over a fairly wide range of concentration, amounting to at least tenfold. It is found, in accordance with previous measurements of vapour pressure, that loading potassium oleate solutions with solubilized *iso*-octane scarcely affects the lowering of freezing-point, showing that it is not solubilized as independent molecules, but that it is taken up in or upon existing colloidal particles.

Nature of the Liquid State

In an article in *Current Science* (**11**, 303 ; 1942) Sir C. V. Raman summarizes some recent work on the scattering of radiation by liquids, from which it is concluded that the basic structure of a liquid is the same as that of the corresponding amorphous solid, though disturbed and enlarged by thermal agitation. The same conclusion is indicated by the study of the X-ray diffraction haloes in liquids and glass. It is the same orderliness of molecular spacing which explains the diminished light-scattering and is also responsible for the diminished intensity of diffraction, at small angles, as compared with the vapour, which is the most characteristic feature of the X-ray haloes of both liquids and amorphous solids. The article is illustrated by a number of typical light-scattering photographs.

Colour Temperature of Convective Stars

From the lists of stellar colour temperatures published by a number of observatories in the last ten years, it is known that the relative gradients or the absolute gradients scatter widely for most spectral types. The cause of this colour temperature spread has been investigated by W. S. Tai and A. D. Thackeray (*Mon. Not. Roy. Astro. Soc.*, **102**, 6 ; 1942), and they suggest that convection, in a limited number of cases, may be the factor. Their investigation indicates that, on the assumption of convection currents existing to an appreciable extent in the photospheres of stars of type *G* and later, such currents may have an important influence on the distribution of energy in the continuous spectrum. The appreciable colour effects due to convection should, it is shown, be expected primarily in a slight reddening of stars of late type. It is admitted that certain results are obtained by assumptions which, while probably true in the solar atmosphere, may not hold for stars of other types, and hence numerical results may be more or less provisional. In addition, the comparison has been restricted to that of a convective and a radiative star identical in other respects—implying an idealized problem. The influence of convection upon colour temperature, although capable of affecting stars of late type in the way suggested, is too small to contribute appreciably to the spread in the case of early type stars.

Orbital Motion and Measurements for Parallax

J. Jackson has published a paper with this title (*Mon. Not. Roy. Astro. Soc.*, **102**, 6 ; 1942), which deals with the effect of orbital motion in invalidating parallax measurements. In the case of visual binaries, where the orbital motion is known, it is a simple matter to allow for this, but in other cases —by far the more numerous—the problem is not so simple. The analysis of the measures of parallax plates requires three unknowns in the equations of condition—proper motion, parallax and a constant ; and observations made at five epochs for these three unknowns frequently show systematic residuals. Although these are not greater than might be expected from accidental error, it is just possible that the residuals arise from orbital motion. An examination of the problem leads to the interesting conclusion that in various cases the residuals can be fitted into a curve with periods of about two years, but these periods are entirely spurious. The investigations of other workers on parallax observations are considered, especially those of Holmberg and Miss Vinter Hansen, whose opinion that parallax determinations may be seriously affected by orbital motion is examined. Her list of 61 spectroscopic binaries in which $a \sin i$ exceeds 0·4 of an astronomical unit (*Pub. Astro. Soc. Pacific*, **54**, 137 ; 1942) shows that a displacement comparable with at least half the parallax may be expected. Jackson points out that 38 of these stars have periods greater than two years and that in only five of these is the error likely to exceed 0·005″, and in only two might it reach 0·01″. His conclusion is that orbital motions with a period of about one year may make parallax determinations unreliable, but if the period exceeds one and a half years the parallax will not be seriously affected. He suggests that extended series of parallax observations should be made of the nearest stars and also of stars with large values of $a \sin i$ and reasonably large parallaxes.

THEORY OF SEA WAVES

By P. J. H. UNNA

RECENT contributions in NATURE on waves[1] have been confined chiefly to cases in which the profiles are trochoidal, but they are not trochoidal when the steepness or the ratio of height of wave to depth of water is large, and adjustments are called for when the waves are near breaking point. The present purpose is to consider to what extent theory provides the clue, and what further information is required.

The following abbreviations are used :

L = length	E = energy per sq. ft. of water surface.
H = height	V = wave speed through water
D = depth of water	G = speed of energy
$S = H/L$ = steepness	q = elevation of orbits
C = stream (negative for foul)	

Suffixes : s = surface	k = kinetic
w = (speed) through water	p = potential
g = ,, over ground	o = deep slack water

Units : lb., ft., sec.

To start at the beginning, L, H, D are necessary to specify a wave, and its behaviour will depend on the ratios D/L, H/L, H/D. Theory as to D/L is fairly complete, provided there is no complication due to large value of either of the other ratios ; for if the latter are small, the waves will be trochoidal for all values of D/L.

Next, it will be convenient to settle the narrowest practicable limits within which D/L cannot be regarded as either large or small. So far as the equations for wave speed are concerned, it may be taken as large provided it is at least 0·4, and as small if it is not more than 0·04, because then the limiting values, $\sqrt{gL/2\pi}$ and $\sqrt{gD}$, will not differ by more than one per cent from $\sqrt{gL/2\pi} \times \sqrt{\tanh 2\pi D/L}$. But it must be remembered that when D/L is 0·4, G/V, that is, $1-(L/V)(dV/dL)$, will be 6 per cent above its deep-water figure of 0·5, and that the run at the bottom will already be a sixth of the wave height.

It will also be convenient to coin some term for waves having D/L between the limits in question. 'Transitional' is suggested, as waves in gradually shoaling water have to pass through a state that is transitional between deep water and 'long'.

When S or H/D is not small, some factor, say A, has to be inserted in the expression for V. It seems that this factor is only required when S or H/D is so large that the waves are no longer trochoidal. Stokes[2] gives $A = \sqrt{1 + \pi^2S^2}$, that is, $1 + 5S^2$, for deep water. Rayleigh[3] confirms this, but going to closer approximation makes $A = \sqrt{1 + \pi^2S^2 + 1{\cdot}25\pi^4S^4}$. The extra term makes a little difference near breaking point.

Michell[4] says that with waves which maintain their form, which presumably means that both crest and trough move at the speed of the wave as a whole, so that the profile keeps symmetrical about the crest, S cannot exceed 0·142 in deep water, and that A is then 1·2—apparently a misprint for 1·1. This compares with 1·12 from Rayleigh's formula. Possibly it is merely intended to be a round figure, so that Rayleigh's may be taken as the more exact.

Wilton[5], professing to carry the argument to a greater degree of precision, puts $S_{max.}$ at 0·132, with V at $2{\cdot}9\sqrt{L}$, giving $A = 1{\cdot}28$. This value for A lies so much above Rayleigh's 'A for S' curve that it is difficult to reconcile the two. The curve would have to be distorted for even moderate values of S to make it hit Wilton's point, and in the absence of any formula for the distortion it will be best to assume that Rayleigh's curve holds good throughout.

No one seems to have evolved an expression for A applicable to transitional waves. It would have to include all three ratios, as the following argument will show. A table was given in NATURE of November 14, 1942, p. 582, to show how deep-water waves change when they reach shoaling water. This table indicates that when D/L_0 = (say) 0·20, 0·10, 0·01, S/S_0 = 1·04, 1·3, 5·75, and H/H_0 = 0·92, 0·93, 1·43. It follows that H/D is at least 4, 9, 140 × S_0. As D/L_0 has to become as small as 0·01 before D/L is reduced to 0·04, this shows that even waves of almost negligible deep-water steepness must break before they become 'long', while steepish ones will acquire appreciable values of H/D soon after they become transitional. In effect, while steepness is the only disturbing factor in deep water, H/D also operates with transitional waves, and does so alone with 'long' ones.

Airy[6] (confirmed by Stokes[7] and Lamb[8]) has shown that when H/D is not small, $A = 1 + 1{\cdot}5\,\eta/D$ for 'long' waves, η being vertical height of water surface above calm-water level, and so negative at the trough. It appears from Lamb that the value of A so obtained only applies to that part of the wave at which the vertical distance in question is measured. So, as $\eta = \frac{1}{2}H + q_s$ and $-\frac{1}{2}H + q_s$ for crest and trough, and q_s for 'long' waves is $H^2/8D$, the difference in speed between crest and trough will be $(1{\cdot}5H/D)\sqrt{gD}$. The wave will take about $L/\sqrt{gD}$ sec. to cover its own length, and while it does so the crest will gain $1{\cdot}5L \times H/D$ ft. on the trough ahead, or $1{\cdot}5H/D$ per foot of travel. So, if the slope of the ground be 1 in X, the gain will be $1{\cdot}5X.H/D$ for each foot of shoaling.

The consequent steepening of the wave front will hasten breaking, and it seems reasonable to suppose that similar, though slighter, distortion takes place with transitional waves, in which case they ought to break in deeper water if the shoaling is gradual. That is precisely the opposite to what Gaillard[9] found. He made two sets of observations, one on the open coast in Florida, and the other on Lake Superior. The former included ground as steep as 1 in 12, while in the latter the slope only ranged from 1 in 90 to 1 in 30. His explanation is that the undertow, strongest where the ground is steep, causes premature breaking. That seems natural, but he seems to indicate that his conclusion also applies as between the flatter slopes on Lake Superior ; and undertow only operates within a wave-length of the shore. If it is merely a question of where breaking starts within that distance, well and good ; but if he also found that the steeper of two flattish slopes caused breaking in greater depth, the matter may call for further consideration. It is of some practical importance, as it affects the protection that an off-shore shoal may be expected to afford to a break-water, according to its ability to make the larger waves break before they reach the actual structure.

Incidentally, a splendid photograph of a wave breaking in Lake Superior at least two wave-lengths from the beach appears opposite p. 123 of Gaillard's book. So far as one can judge, the profile approximates to the theoretical one calculated by Stokes[10], in which, for deep water, the back and front should attain slopes of 30° to the horizontal, and intersect at a clean-cut crest.

Another consequence of the steepening of the wave front is the emergence of long-period waves from what seems to be an absolutely flat sea. At suitable places, well up estuaries, like Porlock or Minehead in England, it is not uncommon to see such waves appear almost spontaneously out of a glassy calm, in the form of steep and quickly growing crests, separated by long flat troughs. They only survive for a few wave-lengths before they break, and their period is in the region of 10 sec. That indicates a distant swell of the order of 500 ft., giving its last kick, and doing so in a way which can be quite spectacular.

Gaillard gives sufficient details of 122 of the breakers on Lake Superior for determining all three ratios, and the results show that breaking does almost always start before the waves become 'long' as suggested above. Thus, while D/L ranged from 0·16 to 0·04, H/L from 0·038 to 0·116, H/D from 0·38 to 0·97, the majority of the figures cluster around $D/L = 0{\cdot}10$, $H/L = 0{\cdot}055$, $H/D = 0{\cdot}6$. H ranged from 2 to 11 ft.

H/L also modifies the relation between H and E. Steepness entails some constant, say B, changing the ordinary equation into $E = 8BH^2$. Dunkerley[11] has shown that in deep water $B = 1 - \frac{1}{2}\pi^2 S^2$; while Gaillard[12] gives $1 - \frac{1}{2}\pi^2 S^2 . \coth^2 \frac{2\pi D}{L}$ for transitional waves. Dunkerley's value is the special case when D/L is large. In the other special case, when D/L is small, and the waves are 'long', Gaillard's expression reduces to $1 - \frac{1}{2}\pi^2 . H^2/8D^2$. The assumption, in each instance, is that the waves are trochoidal, in which case $E_k = E_p$. Rayleigh[13] has shown that E_k exceeds E_p when deep-water waves are so steep that his values of A operate, but the expressions he gives are scarcely in a form which admits of easy evaluation. Beyond this, there seem to be no theoretical estimates of B when either S or H/D, or both, are large.

A good example of the effects of A and B is afforded when they are taken into account in considering the consequences of a foul stream in deep water. The equation[14] connecting C and L is $C = L.V_0/L_0 - V$. Allowing for A, and taking $G_w = \frac{1}{2}V$, the limiting stream, which will cause breaking however small S_0 may have been, becomes $-\frac{1}{4}A^2V_0$, instead of $-\frac{1}{4}V_0$; though it still equals $-\frac{1}{2}V$, for V is changed from $\frac{1}{2}V_0$ to $\frac{1}{2}A^2V_0$. Thus, as Rayleigh's A is 1·100 or 1·117, according as to whether Wilton's or Michell's figure for $S_{\max.}$ be accepted, the limiting stream is increased by 20 or 25 per cent. This gives more probable values than those found before, and which were described at the time as apparently on the low side. With Wilton's A as well as his $S_{\max.}$, the increase would be 65 per cent. The other controlling equation, arising from the crowding up of the energy, is $H/H_0 = \sqrt{E/E_0} = \sqrt{G_0/G_g}$. This becomes $H/H_0 = \sqrt{B_0E/BE_0} = \sqrt{B_0G_0/BG_g}$.

There are thus two equations with three variables, L, H, C, so that L and H can be determined for values of C. There seems to be no doubt as to the value of A, except near breaking point, but the probability is that Dunkerley's B is too high for waves too steep to be trochoidal. Luckily, only $\sqrt{B}$ is involved, so it should not make much difference in any event. Results applicable to all values of L_0 are given below, both when Rayleigh's A is taken into account, and, for comparative purposes, also when $A = 1$. B is taken as unity in each instance. It will be seen that A increases the limiting foul stream by nearly a knot for 100-ft. waves, when $S_0 = 0{\cdot}05$ or 0·025. For other values of L_0 the increase would be proportional to $\sqrt{L_0}$, but the percentage loss in length at breaking point entirely depends on S_0.

Rayleigh's A; $B = 1$			$A = B = 1$		
L	S	C	L	S	C
100	0·050	0·0	100	0·050	0·0
90	0·060	—1·2	90	0·060	—1·15
80	0·075	—2·45	80	0·074	—2·1
70	0·098	—3·85	70	0·095	—3·1
			60	0·128	—3·95
61½	0·132	—5·4	59	0·132	—4·0
60	0·142	—5·8	57	0·142	—4·15
100	0·025	0·0	100	0·025	0·0
90	0·030	—1·15	90	0·030	—1·15
80	0·037	—2·25	80	0·037	—2·1
70	0·048	—3·25	70	0·048	—3·1
60	0·065	—4·25	60	0·064	—3·95
50	0·099	—5·5	50	0·092	—4·7
46	0·132	—6·45	42½	0·132	—5·15
45	0·142	—6·7	41	0·142	—5·2

To apply this table to other values of L_0, increase L proportionately to L_0, and C to $\sqrt{L_0}$.

Relevant equations, $C/\sqrt{L_0} = (L/L_0 - A\sqrt{L/L_0}) \times \sqrt{g/2\pi}$

$S/S_0 = (2L/L_0 - A\sqrt{L/L_0})^{-\frac{1}{2}} \times L_0/L$

A_0 is ignored, being almost unity.

There is one small point about this table. If $\delta V/\delta L$ and $\delta C/\delta L$ be calculated from the part based on $A = B = 1$, the results will conform with the interdependent equations $G_w = V - L.dV/DL = \frac{1}{2}V$ and $G_g = L.dC/dL$, but they will be quite discordant if calculated from the other part. That does not mean to say that A alters G_w from $\frac{1}{2}V$ when change of stream is met in deep water. A similar apparent discrepancy will be found in Rayleigh's table[15] for waves running into shoal water, for if the figures for $\delta V/\delta L$ obtained from that table be applied to the equation for G, the result will be zero for all depths, and that would be nonsense. Perhaps the explanation is that, in one case, an extra variable A arising from change in S, and so from change in stream, is introduced, while in the other there is the extra variable D; and that the waves, at any one moment, cannot 'foretell' whether they are going to meet a different stream or depth at the next one, and so, for the time being, must behave as if A, or D, were constant. Thus modification of the value of $\delta V/\delta L$, due to future change in stream or depth, cannot affect the value of G, and make it ambiguous, before the change takes place.

Lastly, it seems that waves in mid-ocean do not attain a steepness sufficient to make it likely that A or B will materially affect their rate of growth.

[1] Nature, **148**, 226 (1941); **149**, 219 and 584 (1942); **150**, 581 (1942).

[2] Stokes, "Math. and Phys. Papers", **1**, 211.

[3] Rayleigh, "Scientific Papers", **6**, 13. (Rayleigh's "4/5" is misprint for "5/4".)

[4] *Phil. Mag.*, (5) **36**, 430 (1893).

[5] *Phil. Mag.*, (6) **23**, 1055 (1913).

[6] "Encyclopedia Metropolitana", "Tides and Waves", art. 208.

[7] Stokes, "Math. and Phys. Papers", **1**, 172.

[8] Lamb, "Hydromechanics", 6th ed., 262.

[9] Gaillard, "Wave Action", 120–123.

[10] Stokes, "Math. and Phys. Papers", **1**, 227.

[11] Dunkerley, "Hydraulics", **2**, 54.

[12] Gaillard, "Wave Action", 45–46.

[13] Rayleigh, "Scientific Papers", **6**, 14.

[14] Nature, **149**, 219 (1942).

[15] Rayleigh, "Scientific Papers", **6**, 8.

A MODERN STUDY OF CAULIFLORY

THE habit of flowering from buds borne upon the main branches and trunk, known as cauliflory, is well developed in many tropical genera. Couropita, Napoleona, Artocarpus and Parmentiera are well known examples. In Great Britain it is shown well by the Judas tree (*Cercis siliquastrum* L.), often grown in cultivation. In 1928 Prof. J. McLean Thompson began an intensive study of this southern European example of cauliflory and also of the carob (*Ceratonia siliqua* L.). As a result a very interesting paper on cauliflory in the carob, intended for the *Publications of the Hartley Laboratories* in 1941, has been issued instead provisionally in typescript, with a comprehensive series of photographic illustrations and diagrams.

Fig. 1. EXTREMITY OF CAROB BRANCH SHOWING BASIPETAL PROGRESS OF PRIMARY LATERAL FLOWERING.

Linnæus described the carob as triœcious, but McLean Thompson's extensive collections of the plant, in localities from the Maritime Alps to the Spanish frontier, make it quite clear that male, female and hermaphrodite flowers may be borne simultaneously or successively on any tree. As a result growers who discard trees at an early stage as staminate, or try to modify fruitfulness by grafting, are basing their practice on very inadequate observational data.

The outstanding interest of this work is in the new light it throws upon the habit of cauliflory.

The carob is an evergreen; each year the vegetative shoot bears, apparently alternately but actually in 2/5 phyllotaxis, a number of large pinnate leaves. Flowering always commences by the terminal bud exhausting itself in the production of an inflorescence. So long as the terminal bud is vegetative, all lateral

Fig. 2. PORTION OF CAROB BRANCH WITH CLUSTERS OF SECONDARY MALE INFLORESCENCES.

buds are vegetative also, but after the terminal bud has thus become reproductive, flowering from lateral buds begins and works downwards step by step. The primary lateral inflorescences thus formed, when they die back, are cut off by a layer of cork near the base of the inflorescence, leaving a short stump still bearing small dormant buds. From these buds in later seasons secondary inflorescences may arise, the stump then increasing in size. Lower on the stems these basal stumps may continue to increase in size and, by extension of the axis tissues, may be carried up the stem from their original axillary position. Thus wens of tissue are formed from which inflorescences continue to arise, secondary ones from buds lying in pits on the swelling tissue, and tertiary inflorescences from endogenous buds that form in or below the cork phellogen covering these swollen outgrowths and burst outwards through cortex and cork.

Thompson describes these deep-seated buds as lying in the living tree, in deep-seated pockets filled with a mucilaginous fluid which has apparently digestive action and thus frees the newly organized bud meristem from the cortical tissues in its immediate vicinity. The figures reproduced illustrate characteristic terminal, lateral primary and secondary

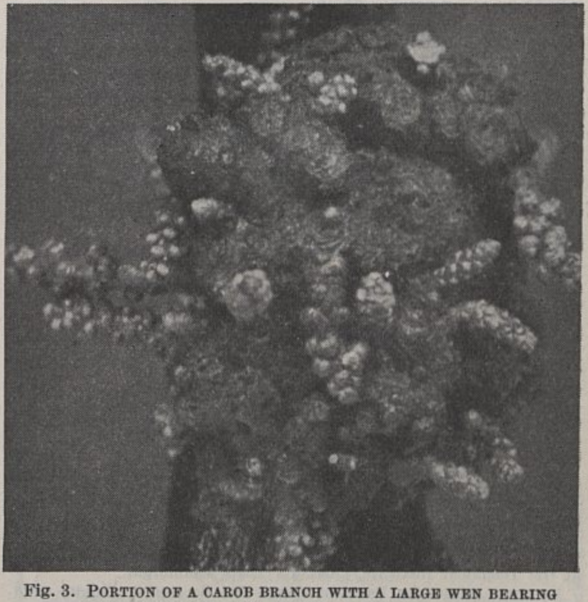


Fig. 3. PORTION OF A CAROB BRANCH WITH A LARGE WEN BEARING BOTH SECONDARY AND TERTIARY INFLORESCENCES.

inflorescences and a large wen bearing both secondary and tertiary inflorescences.

Endogenous buds on roots are, of course, well known, but endogenous buds on stems such as are associated with this cauliflorous habit seem to be a new observation.

Each leaf trace is tri-lacunar, and Thompson shows how the axis, as a result, shows fifteen broad rays in transverse section, grouped in a way determined by the phyllotaxis. Most of the endogenous buds arise opposite the rays, some evidently close to the vascular cambium, in positions where in apple or willow, for example, dormant root initials are frequently seen ; other bud initials may be seen organizing in positions outside this up to the position of the phellogen.

FORTHCOMING EVENTS

Wednesday, April 28

NORTH-EAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS (at Bolbec Hall, Newcastle-upon-Tyne 1), at 6.45 p.m.—Mr. S. Mathwin Davis : "Naval Architectural Education".

Thursday, April 29

INSTITUTION OF ELECTRICAL ENGINEERS (at Savoy Place, Victoria Embankment, London, W.C.2), at 5 p.m.—Sound Films of Honorary Members and Faraday Medallists—Lord Hirst and Dr. F. B. Jewett. At 5.30 p.m.—Prof. D. R. Hartree, F.R.S.: "Mechanical Integration in the Solution of Electrical Problems" (Thirty-fourth Kelvin Lecture).

APPOINTMENTS VACANT

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

HEAD OF THE ELECTRICAL ENGINEERING DEPARTMENT of the Rutherford Technical College—The Director of Education, City Education Office, Northumberland Road, Newcastle-upon-Tyne 2 (April 29).

INSTRUCTOR FOR TRAINING RADIO MECHANICS, WITH GOOD QUALIFICATIONS IN THEORY AND PRACTICE OF RADIO WORK, and A LECTURER IN MECHANICAL ENGINEERING, at the Rugby College of Technology and Arts—The Organizer of Further Education in Rugby, Rugby (April 30).

HEAD OF THE DEPARTMENT OF CHEMISTRY AND METALLURGY in the Wolverhampton and Staffordshire Technical College—The Director of Education, North Street, Wolverhampton (April 30).

LECTURER IN MECHANICAL ENGINEERING SUBJECTS—The Clerk to the Governors, South-East Essex Technical College, Longbridge Road, Dagenham (April 30).

TEACHER OF ONE OR MORE OF THE FOLLOWING SUBJECTS : ENGINEERING, DRAWING, WORKSHOP PRACTICE—The Principal, County Technical College, Gainsborough, Lincs (May 1).

HEADMASTER OF THE WIMBLEDON JUNIOR TECHNICAL SCHOOL—The Chief Education Officer, County Hall, Kingston-on-Thames (May 3).

ASSISTANT LECTURER TO TEACH IN THE BUILDING DEPARTMENT, and AN ASSISTANT LECTURER TO TEACH IN THE TEXTILE DEPARTMENT, of the Junior Technical School of the Burnley Municipal College—The Director of Education, Education Offices, Burnley (May 3).

ASSISTANT MASTER FOR A JUNIOR COURSE IN BUILDING at the Scarborough Technical Institute—The Secretary, Education Offices, County Hall, Northallerton (May 8).

ASSISTANT ANALYST—The City Analyst, 152 Great Charles Street, Birmingham 3 (May 8).

ASSISTANT LECTURER IN ELECTRICAL ENGINEERING—The Bursar and Acting Registrar, University College of North Wales, Bangor (May 15).

ASSISTANT ENGINEERS (CIVIL) for the Government Railways in West Africa—The Secretary, Overseas Manpower Committee (Ref. 397), Ministry of Labour and National Service, Sardinia Street, Kingsway, London, W.C.2.

FIRST ASSISTANT TO THE HARBOUR ENGINEER of the Colombo Port Commission, Government of Ceylon—The Secretary, Overseas Manpower Committee (Ref. 791), Ministry of Labour and National Service, Sardinia Street, Kingsway, London, W.C.2.

GRADUATE LECTURER IN MATHEMATICS AND SCIENCE, and a LECTURER IN BUILDING SUBJECTS (INCLUDING WOODWORK OR PLUMBING) with ABILITY TO TEACH ELEMENTARY MATHEMATICS—The Clerk to the Governors, Technical College, Chesterfield, Derbyshire.

ASSISTANT MISTRESS TO TEACH BIOLOGY AND GENERAL SCIENCE—The Mistress in Charge, Folkestone Day Technical School for Girls, at the Technical Institute, Quaker's Yard, Glamorgan.

VISITING PART-TIME PSYCHOLOGIST—The Secretary, Child's Guidance Clinic of the Lady Chichester Hospital, 33 West Street, Brighton.

REPORTS and other PUBLICATIONS

(not included in the monthly Books Supplement)

Great Britain and Ireland

University of Leeds: The Brotherton Collection. The Seventh Report of the Committee, Session 1941–2. Pp. 6. (Leeds: The University.) [43

The Problem of Unemployment. Pp. 40. (London : Lever Brothers and Unilever, Ltd.) [43

E. A. W. Point of View on Post-War Reconstruction. Interim Report collated by Elsie E. Edwards. Pp. 54. (London : Electrical Association for Women.) 2s. 6d. [53

Are there Human Instincts ? By Prof. T. H. Pear. (Reprinted from the "Bulletin of the John Rylands Library", Vol. 27, No. 1, December 1942.) Pp. 32. (Manchester: Manchester University Press.) 1s. 6d. net. [103

University of Cambridge: School of Agriculture Memoirs. Memoir Nos. 13–14: A List of the Papers published by the Members of the Staff of the School of Agriculture and its Associated Research Institutes during the Period Oct. 1st, 1940–Sept. 30th, 1942. Pp. 8. (Cambridge: School of Agriculture.) 6d. [103

Hours of Work and their Influence on Health and Efficiency. By Dr. H. M. Vernon. Pp. 38. (London : British Association for Labour Legislation.) 9d. [113

National Smoke Abatement Society. 13th Annual Report, 1943. Pp. 16. (Epsom : National Smoke Abatement Society.) [153

War-time Information for Pharmacists. Compiled by the *Pharmaceutical Journal*. Second edition. Pp. 64. (London : Pharmaceutical Press.) 1s. [163

Social Insurance in the Soviet Union. By Maurice Dobb. Pp. 16. (London : National Council for British-Soviet Unity.) 2d. [183

Institute of Welding: Welding Research Council. Technique for the Gas Welding of Copper. (T.6.) Pp. 28. (London : Institute of Welding.) 2s. 6d. [193

Museums and World Affairs: with Special Reference to Engineering and Industry. Presidential Address by Dr. F. J. North delivered before the South Wales Institute of Engineers, at Cardiff, January 21st, 1943. Pp. 28. (Cardiff : South Wales Institute of Engineers.) [193

Other Countries

Annual Report on the Forest Administration of Nigeria for the Year 1941. Pp. 19. (Ibadan : Forest Department.) [43

Annals of the Carnegie Museum. Vol. 29, Art. 13 : A Collection of Lepidoptera (Rhopalocera) from the Cayman Islands. By G. D. Hale Carpenter and C. B. Lewis. Pp. 371–396. (Pittsburgh, Pa. : Carnegie Museum.) [43

Smithsonian Institution. War Background Studies, No. 5 : The Natural-History Background of Camouflage. By Herbert Friedmann. (Publication 3700.) Pp. ii+17+16 plates. (Washington, D.C. : Smithsonian Institution.) [83

Proceedings of the United States National Museum. Vol. 92, No. 3147 : New Species of Bark Beetles (Pityophthorini) from Mexico and Tropical America (Coleoptera, Scolytidæ). By M. W. Blackman. Pp. 117–228+plates 20–23. Vol. 92, No. 3153 : Mexican Herpetological Miscellany. By Hobart M. Smith. Pp. 349–396. (Washington, D.C. : Government Printing Office.) [83

Ceylon. Part 4 : Education, Science and Art (D). Administration Report of the Acting Director of Agriculture for 1941. By E. Rodrigo. Pp. 16. (Colombo : Government Record Office.) 30 cents. [93

Smithsonian Institution. War Background Studies, No. 7 : The Japanese. By John F. Embree. (Publication 3702.) Pp. vi+42+16 plates. (Washington, D.C. : Smithsonian Institution.) [123

Report of the Secretary of the Smithsonian Institution and Financial Report of the Executive Committee of the Board of Regents for the Year ended June 30, 1942. (Publication 3696.) Pp. iii+112. (Washington, D.C. : Government Printing Office.) 25 cents. [123

U.S. Department of Agriculture. Circular No. 643 : Owlet Moths (Phalænidæ) taken in Light Traps in Kansas and Nebraska. By H. H. Walkden and D. B. Whelan. Pp. 26. 5 cents. Leaflet No. 229: The Potato Leafhopper, a Pest of Alfalfa in the Eastern States. By F. W. Poos. Pp. 8. 5 cents. (Washington, D.C. : Government Printing Office.) [123

Indian Forest Leaflet No. 28 : Ash Content of some Indian Fuel Woods. By B. S. Varma and A. C. Dey. Pp. 8. (Dehra Dun : Forest Research Institute.) 4 annas ; 6d. [153

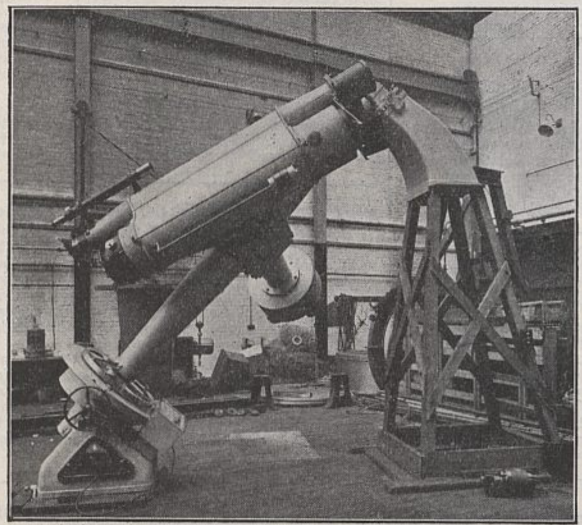
Smithsonian Institution. War Background Studies, No. 6 : Polynesians—Explorers of the Pacific. By J. E. Weckler, Jr. (Publication 3701.) Pp. iv+77+20 plates. (Washington, D.C. : Smithsonian Institution.) [173

Smithsonian Miscellaneous Collections. Vol. 103, No. 7 : The Musculature of the Labrum, Labium and Pharyngeal Region of Adult and Immature Coleoptera. By Carl Kester Dorsey. (Publication 3697.) Pp. ii+42+24 plates. (Washington, D.C. : Smithsonian Institution.) [183

U.S. Office of Education : Federal Security Agency. Education and National Defense Series, Pamphlet No. 6 : What Democracy Means in the Elementary School. By Helen K. Mackintosh. Pp. v+35. 15 cents. Education and National Defense Series, Pamphlet No. 10 : National Unity through Intercultural Education. By Rachel Davis-DuBois. Pp. vi+34. 15 cents. (Washington, D.C. : Government Printing Office.) [183

New Zealand : State Forest Service. Annual Report of the Director of Forestry for the Year ended 31st March 1942. Pp. 20. (Wellington : Government Printer.) 9d. [223

U.S. Department of Agriculture. Farmers' Bulletin No. 1911 : Preventing Damage to Buildings by Subterranean Termites and their Control. Pp. ii+37. (Washington, D.C. : Government Printing Office.) 10 cents. [223



33 cm. Astrographic Telescope with 25 cm. Guider

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

BEIT MEMORIAL FELLOWSHIPS FOR MEDICAL RESEARCH

NOTICE is hereby given that an ELECTION of JUNIOR FELLOWS to begin work on October 1 will take place in July, 1943. Junior Fellowships are normally of the annual value of £400 for three years; but candidates, younger than those usually elected or whose promise for medical research must be judged mainly on work outside that field, may be awarded a lower rate of £300 for the first two years. Candidates are asked to state whether they would be unable to accept this lower initial rate.

Candidates must have taken a Degree in a Faculty of a University in the British Empire or a Medical Diploma registrable in the United Kingdom. Elections to Junior Fellowships are rarely made above the age of thirty-five years.

The Trustees are desirous of furthering research in Mental Diseases and in the general allotment of Fellowships will give some preference to a candidate proposing research on approved lines in that subject.

Applications from candidates should be received by May 14, though late entries will be accepted up to June 1.

Owing to the disturbance caused by the War, it is necessary for candidates to submit evidence that they could be given accommodation in the departments where they propose to work.

Forms of application and all information may be obtained by letter only addressed to:
Professor T. R. Elliott, M.D., F.R.S.,
Hon. Secretary,
Beit Memorial Fellowships for Medical Research,
University College Hospital Medical School,
University Street,
London, W.C.1.

HUDDERSFIELD TECHNICAL COLLEGE

Principal: Dr. J. W. Whitaker, F.I.C., F.Inst.Fuel, M.I.Min.E.

Applications are invited for the position of Lecturer in Mining and Fuels. Applicants should possess Graduate qualifications or equivalent, and should have had industrial experience. Salary—Burnham Scale plus bonus. Forms of application may be obtained from the Principal. They should be returned by May 7.

H. KAY,
Director of Education.

KING'S COLLEGE, NEWCASTLE-UPON-TYNE

(In the University of Durham)

Applications are invited for the post of temporary Lecturer in Mathematics. Duties to commence October 1, 1943. Salary £300 to £400 per annum according to qualifications and experience. Further particulars may be obtained from the Registrar, King's College, Newcastle-upon-Tyne, 2, by whom 4 copies of applications and 4 copies of not more than three recent testimonials must be received not later than May 15, 1943.

W. G. B. OLIVER,
Registrar.
King's College, Newcastle-upon-Tyne, 2.

MURDOCH TRUST

For the BENEFIT of INDIGENT BACHELORS and WIDOWERS of good character, over 55 years of age, who have done "something" in the way of promoting or helping some branch of Science.

Donations or Pensions may be granted to persons who comply with these conditions.

For particulars apply to MESSRS. SHEPHERD & WEDDERBURN, W.S., 16 Charlotte Square, Edinburgh, 2.

BIRKBECK COLLEGE

UNIVERSITY OF LONDON

AUTUMN TERM BEGINS ON FRIDAY, SEPTEMBER 10

Applications for admission from men and women who desire to read at the week-ends for degrees in the Faculties of Arts and Science for B.Sc. (Econ.) intermediate only or for the Diploma in Geography should be addressed to The Clerk, Birkbeck College, E.C.4.

KING'S COLLEGE, NEWCASTLE-UPON-TYNE

(In the University of Durham)

Applications are invited for the post of Temporary Lecturer in Metallurgy. Duties to commence October 1, 1943. Salary £300 to £400 per annum according to qualifications and experience. Further particulars may be obtained from the Registrar, King's College, Newcastle-upon-Tyne, 2, by whom 12 copies of applications and 12 copies of not more than three recent testimonials must be received not later than May 10, 1943.

W. G. B. OLIVER,
Registrar.
King's College, Newcastle-upon-Tyne, 2.

CITY OF BIRMINGHAM

Assistant Analyst required in City Analyst's laboratory. Applicants should possess either a science degree or the Associateship of the Institute of Chemistry.

The salary payable will be £300 per annum rising by £15 per annum to £400. In addition a war bonus scheme is in operation.

The applicant is subject to medical examination and payments are required to be made to the Birmingham Superannuation Fund.

Applications stating age and qualifications and accompanied by not more than three recent testimonials, to be sent to the City Analyst, 152 Great Charles Street, Birmingham, 3, not later than Saturday, May 8.

Applications invited for the post of National Organizer (Male). Experience of trade union work on behalf of professional workers desirable. Please state age, experience. Applicants should not be liable for military service. Salary £350.—Apply to The Association of Scientific Workers, 73 High Holborn, London, W.C.1.

Young man, 23, exempt military service, 1st Class Natural Sciences Tripos, Cambridge, seeks agricultural research work, preferably University town. Agricultural experience.—Box 944, T. G. Scott & Son, Ltd., 9 Arundel Street, London, W.C.2.

IMPERIAL COLLEGE OF SCIENCE AND TECHNOLOGY

A COURSE OF SIX LECTURES BY MR. B. K. JOHNSON, D.I.C. on MICROSCOPY will be given on Tuesdays and Thursdays at 4 p.m., commencing on Tuesday, May 4, 1943, in the Technical Optics Section of the Physics Department.

An optional course of practical work (consisting of 8 periods of 3 hours each) will be arranged during the six weeks commencing May 24, at times to suit those wishing to attend. These courses will be suitable for those having to use the microscope in technical practice; they will include advanced methods in microscopy, and ultra-violet microscopy.

Applications for admission should be made to the Registrar of the Imperial College, Prince Consort Road, S.W.7. The fees are £1 1s. for the Lectures and £2 2s. for the Laboratory work.

Applications are invited for the post of TECHNICAL ADVISER in connection with the supply of fungicides and insecticides by a leading London manufacturer. A good experience of advisory and demonstration work amongst farmers and growers is advisable and applicants must hold an Agricultural or Science degree with specialized knowledge of Plant Pathology. Salary according to qualifications. All travelling expenses paid by the company. Write giving age, position as regards liability for military service, full details of education and experience with copies of two testimonials to Box 941, T. G. Scott & Son, Ltd., 9 Arundel Street, London, W.C.2.

Assistants required for physical laboratory in Tottenham district. Matriculation or similar standard. Apply with full particulars of age, previous experience, salary required, etc., to Box A.C.7, c/o 5 New Bridge Street, E.C.4.

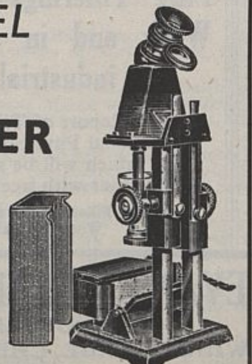
Microscopes, second-hand, a large selection of instruments in perfect condition; 3d. stamp for list. Chards, Specialists (Est. 70 years), Forest Hill, S.E.23.

For sale: Klett-Bio-Colorimeter complete with lamp and three cups, £65.—Box 943, T. G. Scott & Son, Ltd., 9 Arundel Street, London, W.C.2.

For sale: Leitz Ultropak with Objectives, in perfect condition.—Apply Professor of Pathology, University of Bristol.

Wanted.—"Making and Moulding of Plastics" by Bell and "Technology of Plastics" by Rowell.—Write Box 942, T. G. Scott & Son, Ltd., 9 Arundel Street, London, W.C.2.

Ido-English and English-Ido dictionaries, **11s. post free and information on international language, Ido Society, 3 Spareleaze Hill, Loughton, Essex.**



MARINE BIOLOGICAL ASSOCIATION OF THE UNITED KINGDOM

THE LABORATORY, PLYMOUTH

Limited supplies of marine biological material are still available, but orders should be placed well in advance.

For prices and detailed information apply to:
THE DIRECTOR, THE MARINE BIOLOGICAL LABORATORY, PLYMOUTH.

Printed in Great Britain by Fisher, Knight & Co., Ltd., The Gainsborough Press, St. Albans, and published by Macmillan & Co., Limited, at St. Martin's Street, London, W.C.2, and The Macmillan Co., 60-62 Fifth Avenue, New York—Saturday, April 24, 1943.