NATURE

No. 3909 SATURDAY, SEPTEMBER 30, 1944 Vol. 154

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Editorial and Publishing Offices
MACMILLAN & CO., LTD.,
ST. MARTIN'S STREET, LONDON, W.C.2.
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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.

SCIENTIFIC AND INDUSTRIAL RESEARCH.—VI

WE have now completed our survey of the strategy and tactics of research in respect of the workers and organization required, and the broad objectives of programmes to serve the advance of science and the needs of the nation. We have now to view in conclusion, more from outside, the structure thus adumbrated; and to consider, not primarily the service to be rendered thus to the community, but the price that must be exacted from the community in order that such an organization may function effectively and render the services set forth. That support has two main aspects: financial and educational. Research in any field cannot be prosecuted effectively unless support is forthcoming on an adequate scale. Such support in turn is unlikely to be forthcoming unless the reasons for prosecuting research are adequately understood by the public; and once again, the case for research is unlikely to be presented effectively unless the possibilities are fully appreciated by the administrator, whether he be in Government service or in industry.

For our present purpose it is unnecessary to enlarge on the financial aspect. Estimates as to the cost of the programmes and of the organization involved are as yet incomplete or tentative. Many of the essential facts have yet to be determined, and even the programmes themselves to be outlined adequately. Sir Ernest Simon has estimated that the necessary expansion and development of the universities involves increasing the Exchequer grant to £4 millions in the first year after the War and successively to £8 millions in the fifth year, with capital grants on the scale of £20 millions over a period of ten years. The Parliamentary and Scientific Committee likewise visualizes an increase of the Treasury grant to six or seven million pounds, with at least £10 millions over the first five post-war years for capital expenditure, and the British Association Committee on Post-War University Education estimates this capital expenditure at £25 millions. The Association of Scientific Workers puts the total university expenditure at about £15 millions after five years and at £20 millions after ten years, most of which will have to come from the State; accordingly, it anticipates an increase in the annual Government grant to £9 millions after five and to £13½ millions after ten years.

This is only a part of the national research budget directly charged on the State, though, of course, a large part of the university expenditure is only indirectly for research purposes. Estimates as to the increased expenditure involved in the research directly financed by the State are fewer, and in any event are at present largely tentative in the absence of the essential surveys or broad programmes. The Parliamentary and Scientific Committee puts the desirable expenditure on coal research alone at "several millions" and on agricultural research at at least three millions per annum. In its statement "A Post-War Policy for Science", the Association of Scientific Workers puts the cost to the State of the proposed increases at about £18 millions, of which £7 millions would be for industrial research (as against £3 millions pre-war), £6 millions for agricultural advisory services, six hundred thousand for agricultural research, £4 millions for medical research (in place of £2 millions before the War) and half a million for consumer research. Even this estimate takes no account of Colonial research, for which expenditure up to half a million a year has already been provided under the Colonial Development and Welfare Act of 1940, or of the social and economic research adumbrated in the Nuffield College statement and elsewhere.

It is sufficient, however, for the present purpose to note that expenditure ranging up to what might well approach £50 millions can scarcely be appropriated without widespread public understanding of its purposes and implications. It is most important that these calculations should be properly and exhaustively made and that the cost of expansion should be determined and apportioned. But it is even more important, as *The Economist* has pointed out, that in this process the right relation should be devised between the universities and public bodies, including local authorities as well as the central government. That can scarcely be secured unless on one hand the underlying issues are clearly understood by the local authorities, in Parliament and by the electorate, so that decisions are taken free from prejudice or the pressure of private or sectional interests; and on the other, the question of university research and finance is seen as part of, and in relation to, the wider question of the national research effort.

From this point of view, accordingly, it is all-important that in the comprehensive reconstruction of our education system, of which the Education Act embodies the first instalment, the system should be regarded as a whole, from the nursery school to the universities and adult education beyond the university stage. No matter how perfectly our research organization is designed to serve our strategy, embodies the correct tactics and executes the programmes planned, it will only be fully effective when it has the intelligent support of the body of the nation it serves. By this means alone can we be sure, as the history of the last twenty years shows, that no false economy or sudden demand for retrenchment will cripple the long-range plans which would bring immeasurable returns to the nation's balance sheet.

That point of view is clearly recognized by the Government. In admitting the Government's responsibility for giving a lead in this matter of research, the Lord President of the Council, Mr. Attlee, stated in the House of Commons debate that Government support for research must be backed not only by a readiness to use the results of that research, but also by public opinion and by the nation becoming more aware of the importance of science. Mr. Attlee regards the Education Act as an essential means of getting the nation scientifically minded, and stressed that there are three parties: the Government, industry and the general public. Our research effort will not endure unless, as Mr. Attlee said, public opinion is behind it.

No body is doing more in this work of public education than the Parliamentary and Scientific Committee, and Mr. Attlee paid fitting tribute to that work. Such educational work must be carried on outside as well as inside Parliament, and all scientific workers have their own opportunities as well as responsibility for sharing in the task. The Colonial Research Committee, in its first annual report, makes a sound point in emphasizing the importance of actively associating the Colonial peoples, through their Governments, with the planning and guidance of research. This point has an even wider bearing, for it may well be that until we can secure, in Great Britain as well as in the Colonial territories, that the ordinary citizen is associated with the planning of research, at least to the extent of gaining some understanding of its bearing on his everyday life and welfare, we cannot expect the sustained support and endowment of research on the scale now needed.

That task of education cannot be carried out without the wholehearted support and co-operation of scientific workers themselves, on whose shoulders much of the work of exposition and interpretation must necessarily fall. This is particularly true in respect of the special task of educating the administrator as to the potentialities of scientific research. We may indeed hope that further attention to the training of the administrator and manager, as part of our programme of educational reform, will explode the superstition that business and administration cannot be taught in a university, and demonstrate that a university can provide those whose profession is to be industry or business with a three-years discipline in the fundamentals of the problems they will meet in their professional career. Thus we may ultimately provide both industry and Government departments alike with administrators having sufficient scientific background to appreciate the scientific factors in the problems confronting them, and to discharge more adequately and imaginatively such functions as decisions upon research needs and priorities—a long-range task. The immediate problem is that of educating the present generation of administrators, who carry the responsibilities for the decisions that will permit or warp the post-war expansion of research. As Dr. D. R. Pye suggested recently to the London Institute of World Affairs, the primary responsibility of the universities to industry is to supply the qualified men and women, able executives with trained minds and initiative, capable of seizing upon and developing a new idea or a promising new process.

The concern with which the medical profession has viewed the Government proposals for a State medical service is at bottom due to distrust of the administrator. The weaknesses of the Civil servant as summarized in the recent report on "The Training of Civil Servants" . . . "over-devotion to precedent; remoteness from the rest of the community, inaccessibility and faulty handling of the general public; lack of initiative and imagination; ineffective organization and misuse of manpower; procrastination and unwillingness to take responsibility or to give decisions" . . . may be exaggerated, but undoubtedly exist, and Prof. H. J. Laski is right when he says that the control of research is often in the hands of men with no serious acquaintance with the possibilities of either natural or social sciences. If this situation is to be rectified, the tendency to departmentalism checked, means found for securing that Government departments are aware of the relevance of achievements of scientific men in other countries, and a more youthful outlook and representation achieved in the direction of the relations between the Government and science, scientific workers must translate their concern for professional and intellectual freedom into a sense of social responsibility which issues in both individual and in corporate action.

Dr. D. W. Hill, in his recent book "The Impact and Value of Science", has put his finger on the weak spot: "Until they have learned to express themselves, scientists will continue to be wallflowers at the world's quickstep". The faults are not all on one side. The indifference and even scorn with which scientific workers have treated this task of exposition is every bit as serious as the defects of the administrator already mentioned. As Dr. Hill says, scientific men must learn to write and to speak so that people will listen to them, and will understand and appreciate their efforts. In place of the isolationist and sometimes arrogant attitude to the administrator, scientific workers must adopt a sympathetic and co-operative attitude: they must seek to help, not to dictate. The task of intelligence calls for tact and sympathy and for imagination on both sides. The man of science as well as the administrator needs to be sensitive to opinion.

These factors are as important in the running of our research organization and in the functioning of its information services as lubrication in running a machine, and especially so in dealing with the present situation, when we cannot wait for a reformed educational system to provide us with improved types of experienced administrators. There is, however, another aspect in which educational reform is important to our plans for the expansion of research. The Association of Scientific Workers has pointed to the need for increasing the supply of laboratory technicians in order that we may make full use of even the existing numbers of trained scientific workers. Equally important is the supply of technicians in industry, and no plans for the expansion of applied research which take no account of the facilities for technical education can be expected to fructify.

The dependence of Great Britain's post-war plans on the provision made for technical education has been repeatedly emphasized of late. It is recognized, as the Nuffield College paper points out, that the management of a firm should include men with a sound knowledge of basic scientific principles and methods. The Government and the public should be similarly equipped. Thus, in the long run, the general need is for a spread through the educational system of a sound knowledge of basic scientific principles and method. Sir George Schuster urged in the House of Commons the need for a very great increase in the number of scientifically trained workers and for a very rapid development of all forms of scientific and technical education; and the Government educational programme was strongly criticized from this point of view in the House of Lords. The report of the London Chamber of Commerce on Scientific Industrial Research also recognized the importance of this question of technical education and urged the allocation of a far larger sum for the development of technical colleges than the £100,000 envisaged in the White Paper on Educational Reconstruction. Similarly, the report of the Parliamentary and Scientific Committee directs attention to the need for a great expansion in technical education, for reconsidering the position of the technical institutions with reference to the universities, and to the value of the large number of technical personnel now in the Forces, if suitably trained, on demobilization.

There is a further point stressed in this same report, as well as in that of the London Chamber of Commerce, which has frequently been overlooked. It is essential to find some means of restoring the status of the craftsman or artisan and technician, both in the laboratory and in the works. When all has been said about the necessity for further provision for technical training of the skilled workers and craftsmen which industry will require in growing numbers, to remedy the present inadequate provision for this purpose will not by itself be enough. There is an important body of industrial opinion which holds that the provision of technical education in Great Britain is inadequate and defective primarily because the country undervalues the man who works with his hands, and regards him as socially inferior to the office or professional worker.

To remedy a perverted social attitude is a matter that lies outside the field of education, in the limited sense of that term, and while the scientific worker will urge the importance of adequate provision for the technical training of the craftsman as bearing vitally on industrial efficiency and the effectiveness of our research organization, he cannot fail to note that here again he must accept some responsibility for attempting to reverse that attitude. More might undoubtedly be done by the example of professional associations, and the scientific worker is prone to overlook the influence that his own personal conduct and attitude may have on his fellow citizens and workers. Social attitudes may be reversed less by propaganda than by the quiet pervasive influence of conduct determined by principles firmly held and resolutely but sympathetically and sincerely explained.

It is not only the general public and the administrator who in such ways as these must be educated to understand the needs and possibilities of the situation in order to enable our research organization to function effectively. Reports from the Department of Scientific and Industrial Research have repeatedly stressed the need for more publicity in industry, and for the education of industry, in order to make the work of the research associations, for example, effective. It has become an important function of some research associations to secure the translation of their results into terms which are easily assimilable by the industry. The task of public relations has acquired a special significance in this respect for securing that industry is research-minded, and both the report of the London Chamber of Commerce and that of the Industrial Research Committee of the Federation of British Industries have directed attention to this point.

The London Chamber of Commerce urges that chambers of commerce, trade associations and industrial federations should give attention to this question of publicity generally, providing information and advice as to the steps to be taken by firms to get specific research done for them and to utilize the research facilities available. It also suggests that the B.B.C., the Press and the cinema should be used to stimulate interest in scientific work and to interpret the results of that work when applied to industry. That was to be one of the functions of the co-ordinating secretariat for industrial research suggested by Dr. P. Dunsheath, and it is one of the main functions of the bureau of industrial research suggested by the Federation of British Industries. This bureau, though supported financially by research associations, independent research laboratories, Government research establishments, universities and others, would be entirely objective in its activities. Among its suggested activities are the publication of a year-book, in which could be included a short description of the achievements of British research and of the facilities available for the prosecution of research, and educational publicity on research.

In addition to advisory functions on research problems, the Federation of British Industries' Committee visualizes such a bureau as possibly creating a liaison between research workers in similar or related fields. Its existence would in the opinion of the Committee increase the research-mindedness of British industry and foster a greater national sense of the importance of the subject and its influence in maintaining national prosperity and well-being. It might indeed assist in imparting to those responsible for management in large or small firms a scientific approach and understanding of their problems, and encourage a readiness to give a high place in business affairs to the claims of scientific research; though it can never absolve us from the responsibility already indicated of thinking in terms not only of supplying industry with adequate staffs of experienced research workers but also with managements capable of co-operating fruitfully with them.

The importance of establishing some new machinery for such purposes and of providing adequately for the organization of information or intelligence services is clear, but it must not be forgotten that organization by itself is not enough. We have already outlined the kind of organization which may be required to serve the broad strategy of research and to execute the programmes which may be planned to serve the national needs. We have stressed the need for keeping that organization flexible and sensitive, for development in accordance with the experience of the past, for avoiding compartmentalism or departmentalism; and that in our planning the first attention must be given to the supply of the right personnel.

In this matter of securing adequate and sustained support of research and the effective utilization of its results, the question of personnel again comes before organization, but with a different emphasis. Success in such publicity and educational work depends largely on those who carry it on, and here the scientific worker must always have a large, and at the start a major, responsibility. Educational reform is a slow process, and the full effects are only felt after a period of years. The immediate task of educating the general public, the administrator and industry as to what is involved must be done largely by them or not at all; and if it is not done, our plans for the expansion and development of research are unlikely to go forward.

Scientific workers will not knowingly neglect their responsibilities, great or small, in such matters as the strategy, the planning or the execution of research. There are signs of an increasing concern with questions of tactics and that the professional associations may take wider and more public-spirited views on some of the problems calling for corporate action, to which in the past they have been indifferent. But the majority of scientific workers have scarcely realized the crucial importance of this task of interpretation and exposition involved in the education of the public, which must proceed step by step as our plans for scientific research are developed.

Research organization may be perfectly designed to serve the purposes of our strategy; research programmes may be comprehensive and well co-ordinated; but no excellence of administration or tactics can eliminate the dependence of success or failure on the human element. The research worker, too, does not work in a vacuum. He has relations with the Government or administration, with fellow scientific men in other branches of knowledge, with his fellow citizens in industry and elsewhere. Organization can only provide the means for co-operation, but without the determination or desire to co-operate and some sympathetic understanding of other points of view, organization will not function.

The adequate organization and planning of research involves a great partnership in which the scientific man, whether he be research worker or administrator or expositor, must take his place with those engaged in Departments of State, in industry and in a real sense the general public. The special responsibilities which fall on men of science in formulating strategy or planning programmes, in criticizing constructively the strategy, tactics or organization of research, as well as for the actual prosecution of research, must not lead them to overlook this further re ponsibility. The prosecution and organization of research can in fact only yield their full results when this task of interpretation and exposition—of educating public opinion as to what is required—is discharged with vision, imagination and persistent resolution, and in a spirit of public service which matches the devotion which scientific workers instinctively bring to the quest for truth in the laboratory.

A NEW ENGLAND NATURALIST

A Naturalist at Large

By Thomas Barbour. Pp. xii+314. (Boston, Mass.: Little, Brown and Company, 1943.) n.p.

IN the lives of the older naturalists, as of Louis Agassiz when he was young or John Hunter when he grew old, we find examples of quite peculiar happiness. All their labour was for the love of it; they did exactly as they pleased; they shared a carefree corner of the world with the painter and the poet. Dr. Thomas Barbour is one of the last of the old-fashioned naturalists, and it is the same way with him. He confesses, or boasts perhaps, that "he never does anything he don't want to do—not if he can help it"; and in consequence a glow of happiness runs all through his random reminiscences.

Dr. Barbour has been a museum man all his days, first in Boston, then in Salem, and lastly in the great Agassiz Museum in Cambridge, Mass., which he has had charge of for many years. He has the golden gift of friendship. He has known all the naturalists of his time; he has travelled far and wide, and his fellow-naturalists all the world over have a friend in him. He is a famous museum curator. He has added immense collections to the great museum founded by the elder Agassiz and enriched by his son; he knows what to store away and what to exhibit, and how to label a nightingale or an albatross for the instruction and benefit of ordinary unpedantic mankind.

Rumphius and Wallace set him travelling (with his young bride) to the Dutch East Indies, as they have led so many another naturalist on his way. There, in Ternate, he shot the Rajah's own cockatoo (and had "the devil to pay"); and found a wonderful lizard "with a great fanlike sail on its back and tail, like a Permian Pelycosaur in miniature", which Wallace and Max Weber had both failed to discover. He has explored Central America and Mexico, made countless journeys to the West Indies, visited South Africa later on, and brought stories as well as rich collections from them all. He has a fresh boyish enthusiasm for every rare and beautiful creature. A certain mouse from Darien, golden-brown above and pearly white below, is "a veritable gem among mice"; a tiny frog from Trinidad, living up-country in Bromelia flowers, is "a lovely little creature, tiny, but with eyes like jewels"; and a crystal-clear pool in a Cuban cavern holds "fairy shrimps of a most heavenly crimson, with white tips to their appendages as if they had stepped about delicately in white ink". They had been lost and forgotten, since they were seen long before by Felipe Poey, the first great Cuban naturalist. Dr. Barbour is a botanist among many other things, and for many years he has been in charge of the garden at Soledad, in Cuba, which belongs to Harvard University, and is now one of the great tropical gardens of the world. One of the inhabitants of this famous garden is "an indescribably lovely little frog, scarce a quarter of an inch long from stem to stern"; it had been described by Cope, and lost sight of for some sixty years. At Maracay, near Caracas, he saw the wonderful zoo which the old dictator Juan Vicente Gomez had formed, with the help of one of the Hagenbecks. Here enormous hippos lived in a pretty lake—around which giraffes, zebras and a host of antelopes wandered as if they were at home; and here were many greater rarities, such as spectacled bears from the Andes, the only bear in South America, and a whole colony of Pacaranas, or Dinomys, one of the largest of all the rodents, very curious and exceedingly rare, unknown to our own Zoo and to the British Museum.

Dr. Barbour is not less interesting when he talks freely of his fellow-men. He has some new stories to tell of Cope and Marsh, the two great palæontologists, bitter rivals and cunning foes; of David Fairchild, who married Alexander Graham Bell's daughter, and became a world-famous gardener and agriculturist; of Samuel Garman and H. F. Osborn and Leonard Stejneger; of E. S. Morse and of the much-loved "Uncle Bill Wheeler", who only died the other day; of President Lowell, and of Oliver Wendell Holmes (the judge not the professor) "who was one of the greatest men I ever knew—perhaps the greatest", but with one blind spot, common enough in frail humanity.

There is a modest paragraph about the luncheons in Dr. Barbour's own den in the Agassiz Museum—he calls it the "Eateria"—which Henry Bigelow and he set agoing years ago, and to which countless scientific men from all the world over have been hospitably bidden and been glad and proud to come. The cuisine is justly celebrated, even since "old Gilbert" died; and there are said to be tanks in the basement where turtle and terrapin await the illustrious guest.

This is a very human book, by a very lovable man. There is a certain oddity about it, and about him—which comes of working in a museum, and loving it, all his life long. For to be a true museum man, as Tom Barbour (or his daughter) says, "You don't *have* to be crazy, but it certainly helps".

D'ARCY W. THOMPSON.

PSYCHOLOGY FOR MEDICAL STUDENTS

Sane Psychology: a Biological Introduction to Psycho'ogy

By Prof. R. J. S. McDowall. A revised and enlarged edition of "A Biological Introduction to Psychology". Pp. xii+275. (London: John Murray, 1943.) 9*s*. net.

THE urgent necessity that the medical student should know as much as possible about the workings of the normal as well as the abnormal mind needs no underlining, though it has recently been emphasized by the General Medical Council. The present book, "for students of medicine, theology and education", is a brave attempt to meet these needs.

It seems fair to set down some requirements of a modern text-book of general psychology. (1) It should be simply written. (2) It should give numerous everyday examples of normal experience and behaviour, including that of children. (3) Abnormal psychology should not be regarded as determining the lines of normal psychology. (4) The concept of mental normality should be fully discussed, with especial reference to the relation of personality to culture-pattern; a normal commando-member who behaves like one, a week after the War ceases, will provide a headache for the ex-army psychiatrist also recently demobilized. (5) The theoretical and practical value to psychology of physiological knowledge should be realistically indicated; study in minute detail of tiny bits of the lower animals is not always the best guide to a medical man trying to understand an intelligent delinquent or a hysterical amnesic. (6) It should appreciate the very extensive recent study of the individual personality, of idiographic as well as of nomothetic psychology. (7) The zoolatrous leanings of the early twentieth-century psychologists should be re-interpreted in the light of recent work by Americans. (8) And, arising out of (7), there should be recognition—especially desirable in a book written for 'medicals'—of the part played by culture in human life; by art, music, humour, philosophy, religion.

I suggest that Prof. McDowall be given good marks for (1), (2), (3), (5), and be referred for further study concerning (4), (6) and (8).

The medical student will welcome this book, with its convenient sub-headings, good index and bibliography. It will help him to answer examination questions, and provide excellent clinical examples when he is justifying psychological medicine to excessively extraverted athletes, or perhaps to his medically qualified father and grandfather. But another book, or lectures, will be needed to remind him of many happenings in the world of psychology during the last thirty years. One is the dropping of the word 'lunatic' and 'asylum' by the general public (writers on mental disease are catching up).

But many young students nowadays read psychology as part of their general education. They will rub their eyes at certain chapters in the present book and ask: Do nations think? Have nations instincts? What are the facts behind the assertion "the desire to learn may be largely hereditary" (there must have been a lot of hereditary learners lately in the U.S.S.R.)? Why is there nothing about the transformation and functional autonomy of human motives? Does the author's frequently and honestly expressed attitude towards medical practice and medical students merely reflect his own culture-pattern, and what would the recently qualified medical practitioner think of it?

A competent lecturer, however, can fill in these gaps—until, as I hope, Prof. McDowall does it himself in yet another edition of this book. But may we hope for a different title? Prof. McDowall is certainly a sane psychologist. Is there, however, such a subject as 'insane psychology'? Until I see books entitled "Schizophrenic Physics" or "Homophobic Biology" I shall continue to think the present title perfectly terrible. T. H. Pear.

VARNISH-MAKING

Varnish Constituents

By Dr. H. W. Chatfield. Pp. xvi+496+12 plates. (London: Leonard Hill, Ltd., 1944.). 35*s*.

THE title of this book immediately carries the mind to varnish-making, a subject with its own small and select but most engaging literature for anyone who is willing to venture a little. Dr. Chatfield's book takes its place, as it were, at the end of the row; but how different it is from some of its predecessors. Naturally his book has been produced to the authorized war economy standard, but even without that measure of austerity, the book would still carry the air of battle-dress—business-like and efficient, everything set out in order, plenty of detail arranged in tabular form, a contents page (nine pages, in fact) minutely analysed, and a substantial index.

All this, no doubt, is in the spirit of the times, but how different from another notable book on the same subject by Sabin, written (actually it was re-written) and published during the War of 1914–18 and entitled "The Industrial and Artistic Technology of Paint and Varnish". Both these books have their place indeed, the one for the office and laboratory, the other for the laboratory and the leisurely student after business hours. It is to be hoped that the modern touch will not deprive us of the interesting historical references, the little anecdote, including, for example, the story of how the craft of varnish-making was brought to England and particularly to the city of Ripon, about 1770. Even the firm with which Dr. Chatfield is now associated has been engaged in the craft since 1803. Surely some historical survey of the subject, however short, is necessary to a full appreciation of the craft as it is practised to-day, for in spite of its strong chemical, and particularly synthetic chemical, background, it is still in large measure an art practised by craftsmen.

Working backwards in time, the present War has crowned the synthetic chemical aspect of varnish technology which grew between the Wars and became the outstanding feature of the period. To-day, many operations associated with varnish-making are carried on in a way sufficiently large to provide problems in chemical engineering; there will be more of them as chemical processing develops. Indeed, it is most likely that linseed oil, hitherto the oily bulwark of the industry, will come to be regarded more and more as a material for chemical manipulation into products which will in turn be regarded as the true raw materials of the industry.

The suggestion that drying oils from petroleum will be available after the War (for in the United States they are even now being used to some extent) is no idle boast, and the picture presented by the advertisements in current American technical journals, fantastic as they may appear to the older generation, do forecast more than a modicum of the shape of things to come.

The post-1914 war developments in varnish-making technology and the form they took were determined first by the widespread appreciation of the valuable properties of tung oil arising out of war experience with products made therefrom; secondly, there was the amazingly rapid development of the nitrocellulose lacquer industry, which is an almost classic example of turning swords into ploughshares.

The stirrings of mind and method which have brought the industry to where it is to-day began about the turn of the century or perhaps a little earlier. This was the time of the scientific revolution when organic chemistry began to open up, and when, to quote a few items that casually come to mind, rosin was esterified, Baekeland began his work on phenolic condensation products, and a survey was made of the natural resin resources of different parts of the world. The impact of this developing scientific background made manufacturers begin to think; but it was a long time before it was obvious to many of them (and indeed to-day it is not yet obvious to all of them) that it was necessary to abandon, or at least modify in favour of the scientific approach, those well-established methods which had flourished and served the industry so well during the period from about 1840 until 1900, when England was the premier varnish-making country of the world and the industry enjoyed great prosperity. The eighteenth century was the period of transition. Up to then varnish was mainly associated with artists, and its making was part of their scheme of work. After then the uses of varnish became more widespread and various, and varnish-making gradually became a specialized industry. So one could travel backwards through the materials of medieval painting almost to the beginning of civilization and find much of interest relating to varnishes of one kind or another.

There is no doubt that this book will be appreciated, for even if Dr. Chatfield has not concerned himself with historical matters, he has collected a mass of useful and very up-to-date information about materials and their processing, which the worker in this field will find extremely useful. More and more of the products of chemical industry, particularly that part of the chemical industry associated with plastics, are being proved suitable as raw materials for varnish, in such variety as to force increased specialization and to develop a serious divergence in thought among technologists as to what is happening to the industry and what its future course will be. At the moment the varnish industry is certainly a case of chemical indigestion—much too much has been and is still being put upon the plate. Probably most of the technologists and scientific men concerned are trying to form, or maybe have formed, a working hypothesis to guide their actions ; but it is doubtful whether many of them are wholly satisfied with their mental picture. This book will help to clarify some of the issues and may perhaps result in better co-ordination between the views of leading technologists. It will—and this is more important—help individuals who have only sketched in the barest outline of their mental picture of varnish-making in the post-war period.

In the author's preface, he says that, having felt the need personally for collected information about the properties of available raw materials and their manner of use, he has attempted to review the more important developments of recent years and to fit them into a complete whole. Unquestionably he has done what he set out to do and has done it extremely well. The review method he has adopted, however, has weaknesses, because so many references to patents and to other reported experimental procedures are inevitably included which are of no particular value and are sometimes misleading. In general, the reader is left to form his own judgment as to the value of the record given, but what is wanted is a weighted appreciation of all the evidence presented ; indeed, in those sections of the work with which the author is clearly more at home he has done this to some extent in spite of his disclaimer that : "I have presumed to dogmatise and criticise as little as possible but rather to present the intelligent reader with the evidence from which his own conclusions may be drawn". The reader will surely form his own conclusions when he can, but he cannot always do so, and in any event he will like to have the professional's, that is the author's, conclusions as well.

As to the actual contents of the book, it is implied in what has already been said that the subject has been treated as on a broad canvas, with many items, some treated in fair detail, others less so, according to importance and the inclination of the author. There are no sections or aspects of varnish-making and varnish-making materials to which some reference will not be found.

L. A. JORDAN.

RADIO WAVES AND THE IONOSPHERE

Radio Waves and the Ionosphere
By T. W. Bennington. Pp. vi+81. (London : Iliffe and Sons, Ltd., 1944.) 6*s*. net.

A VAST number of people are nowadays interested in one or other of the aspects of radio communication, and they are necessarily concerned with the manner in which radio waves are propagated around the earth's surface and to distances beyond the horizon. These and older students of the subject have become aware of the fact that such propagation is possible as a result of the existence of the ionosphere—those regions of the earth's atmosphere which become electrically conducting by ionization chiefly under the influence of ultra-violet radiation from the sun. It does not, however, require much delving into the subject to discover that the ionosphere is not simply equivalent to a metallic electrically conducting sheet in the same position at all times and seasons. It is rather in the nature of a series of partially conducting layers, one above the other, each varying in height and conductivity with time, and the lower layers sometimes shielding the upper ones from radio waves transmitted upwards from the earth's surface. Whether or no such upgoing waves are deflected back to earth from the ionosphere depends upon solar conditions, time of day, season of year, position on the earth's surface, and upon the frequency of the radio waves and the angle at which they are projected upwards from the earth.

While there is an extensive scientific literature giving the results of original investigations into this somewhat complicated subject, it has not hitherto been easy for the 'man-in-the-street' and the general scientific student to gain a clear view of the salient points in this field. In his recently published little book, details of which are given above, Mr. T. W. Bennington has filled this gap in an admirable manner ; and he appears to have achieved his desire to provide a very lucid account of this subject for the benefit particularly of those whose knowledge is confined to school physics and the elements of radio communication.

The scope of the book is well defined on the comprehensive contents page, which has rendered an index unnecessary. After drawing a distinction between ground and sky waves, descriptions are given of the main properties of the ionosphere and the radio methods by which these are explored. The variations in heights of the various regions and their critical frequencies as determined by the density of ionization are described in some detail with the aid of well-selected samples of data obtained in Great Britain and in America. Later chapters deal with the part played by the ionosphere in long-distance radio transmission, and with the influence of the above variations and of ionosphere disturbances and other abnormalities on the effectiveness of the resulting communication. In addition to being written in an interesting manner, the book is scientifically accurate ; and altogether the following comment given by Sir Edward Appleton in his foreword is well deserved: "Although it is primarily written for the professional radio technician who wishes to understand more about his own subject, I recommend it as a friendly and well-informed guide to anyone interested in long-distance radio communication."

POST-WAR UNIVERSITY EDUCATION

By PROF. FRANK HORTON, F.R.S.

THE report of the British Association Committee on Post-War University Education, published on August 1, had its origin in the conference on Science and World Order held under the auspices of the Association in September 1941. The Committee was constituted under the chairmanship of Dr. Maxwell Garnett with the following terms of reference:

1. To consider the general policy and methods of university education with a view to promoting international collaboration and the free interchange of ideas, and relating university education to the needs and service of the community.

2. To consider the replanning of teaching departments and curricula in accordance with modern conceptions of the interrelation of different branches of knowledge, particularly those of science and the humanities.

3. To survey the position regarding teaching material, apparatus, books and staff in universities which have been damaged, disorganized or closed as a result of war, and to make recommendations for their rehabilitation.

The Committee published interim reports in 1942 and 1943, in which it set forth its views together with recommendations on various aspects of items 1 and 2 of its terms of reference, in so far as these deal with university education in the United Kingdom, particular points with which these interim reports have dealt being university entrance scholarships, university finance in Great Britain, universities and the public service and universities and adult education. The subject-matter of all these reports together with the findings of the Committee on other matters within its terms of reference are incorporated in the final report which is now published*. This has a preface by Sir Richard Gregory, president of the Association, and is divided into three sections corresponding to the items of the Committee's terms of reference, but deals in the main with those developments of general policy and methods which the Committee considers desirable in both school and university education in Great Britain.

How can we sum up what should be regarded as the outstanding educational needs of the community at the university-level, the satisfaction of which should be aimed at in university policy? The answer given in the present report is: (1) to get into our universities a larger proportion of those who are going to be the leaders of their generation; (2) having achieved this end, to educate them in such a way as to enable them to cultivate a wider and more integrated outlook on life as a whole; (3) for universities to take a far bigger part than they have done in the past in the education of those who enter the public service, not only before entry, but also after some experience of the service has been gained, and in providing an opportunity of university education for officials of lower rank than have normally enjoyed this privilege; (4) for the university schools of education to play an essential part in the education of all qualified teachers; (5) an expansion in the provision for vocational and non-vocational adult education.

The consideration of how to achieve the first two of these aims has led the British Association Committee to much serious criticism of present scholarship examination systems and of both school and university education. The Committee shares the prevalent view that a much more extensive provision of State and local aid to finance a much greater number of students through a university career is essential in our future educational policy. The Committee appears to envisage the increase of the number of these awards to such an extent that, after meeting the needs of all the candidates of outstanding intellectual promise, there would still be a number of awards available for candidates of less ability whose claims to consideration would be based mainly on their possession of social and civic qualities. It would seem that some adequate system would have to be devised for assessing the other factors which contribute to what the Committee terms "university-worthiness". The best the Committee can suggest in this respect is, after making awards to the candidates of high intellectual promise, "to pick the others empirically on a general impression of their scholarship-worthiness and without attempting an order of merit". Here we seem to be up against an identification of university-worthiness with scholarship-worthiness, and a disregard of the fact that, even if the number of awards is greatly increased, it is unlikely that this number will be as large as the number of candidates, so that an order of merit must be decided.

These awards are all spoken of as "scholarships" by the Committee, but we feel very strongly that the term "scholarship" should be limited to an award which is given for high intellectual ability and should not be applied to an emolument awarded mainly for social and civic qualities. The designation "State bursary" which has been used during the War to describe the emoluments awarded by the Board of Education, sometimes to students of little outstanding ability, might perhaps be continued.

It is suggested in the report that to prevent boys and girls of high intellectual ability from having to do a round of scholarship examinations in the hope of obtaining sufficient funds to finance their university careers, winners of open scholarships or exhibitions at Oxford or Cambridge (or successful candidates for admission to the women's colleges at those Universities) should be treated as if they had won national scholarships. So far as open scholarships are concerned it is generally agreed that this would be a good plan, provided the number of such awards is maintained at about its present level and the monetary value of the scholarships is not diminished; but it is clear that such a scheme, if adopted, must apply also to open scholarships awarded at other universities and not be limited to Oxford and Cambridge. In regard to the suggestion that all successful candidates for admission to the women's colleges at Oxford and Cambridge should also be treated in this way, one feels that the Committee cannot have realized the consequences of such action. The annual admission to the women's colleges at Cambridge is about 150 and at Oxford about 250, and thus the scheme might involve a yearly total of approximately 400 national awards being ear-marked for women at Oxford and Cambridge out of a grand total of about 1,600 annual awards contemplated for men and women together in all the Universities of England and Wales.

The outstanding theme which underlies all the Committee's criticisms of present higher school certificate examinations, university scholarship examinations and university curricula is over-

* British Association for the Advancement of Science. Report of Committee on Post-War University Education. Pp. 52. (London: British Association, 1944.) 2s. 6d.

specialization, which the Committee, in common with other bodies which have published opinions on the subject, sees as a menace permeating the whole system of education and resulting in failure to cultivate a wide outlook on life as a whole. The universities are blamed for forcing this over-specialization on the schools by their system of selecting entrance scholars and also by supplying the schools with too high a proportion of specialist teachers. In its effect on boys who are not of exceptional intellectual quality, the scholarship system, especially that part which operates through the higher school certificate examinations, is described as giving rise to a product which, at the end of a university course, is scarcely adequate to the daily experiences and social contacts of a routine job in life. This condemnation of the whole range of the educational system is very sweeping, and we cannot but feel that the members of the British Association Committee must have been singularly unfortunate in their contacts with the products of that system who owe their university careers to their performances in higher school certificate examinations. The universities are taxed also with having failed to develop character and leadership, and with handicapping the growth of these qualities in that fraction from the poorer homes which is admitted to the universities through scholarships, by giving them a "one-sided education of a pernicious kind". So far as we can gather from the report, the perniciousness of the education lies in its specialized character and the lack of what the Committee describes as an integrating principle. 'Pernicious' is a strong word, and we do not see that any case is made out in the report which justifies its use.

The remedy suggested by the Committee begins with a new sixth-form curriculum in schools. The authors of the report would like to see a sixth form programme comprising "four general courses covering, respectively, the humanities, the social sciences, the physical sciences, and the biological sciences, affording a connected and complete, if not very profound, view of the whole of civilisation and life". It is suggested that English expression, a modern language, and sometimes mathematics might also be included, and it is envisaged that half the time spent in class would be devoted to these or a similar range of subjects, and the remaining half to the study of one special subject which would also occupy as much of the pupil's private study as he chose to devote to it. In recommending the allocation of so much of the time spent in class to non-specialist studies, the report goes beyond the suggestions in the report of any other body we have seen, and it is doubtful whether a pupil would gain any real advantage from the general courses unless he were encouraged to spend a proportionate amount of his private time on the subjects they comprise.

Alongside this modification of the sixth-form curriculum, the Committee recommends an increased encouragement of extra-curricular activities, and emphasizes that the effectiveness of the proposed changes would depend upon there being a corresponding modification of all scholarship examinations. It expresses itself as being strongly in favour of following this up by the introduction in universities of a type of general degree course, including both natural science and the humanities, which it hopes many students would take in preference to the more specialist courses. The report gives in some detail an account of what is envisaged as comprising such a course in "Philosophy, Natural and Social". One wonders whether those primarily interested in the study of the humanities would be satisfied with the share allotted to their subjects in the programme outlined. As a course for those chiefly interested in science, there is much to be said in favour of a syllabus of this kind, though there seems to be an over-estimation of what a student is capable of doing properly in a given time in the insistence that candidates for honours, in addition to being examined in the subjects of the course, should have also to translate and comment upon passages from French and German authors, *including set books*. If the study of the sciences outlined, their history and social significance, is to be serious and not the acquirement of a mere smattering of information, there would surely be little time available for any study of set books in foreign languages which would have real educational value.

For those undergraduates who choose to follow specialist courses in natural science, the Committee advocates the introduction of some study of sociology and citizenship by means of "special interest courses", general courses, and discussion groups, all conducted by persons understanding, and in sympathy with, the background interests of the students. It is not clear whether it is the intention that these studies should play any part in the examination for the degree.

In the conviction that it is the duty of universities to ensure that every undergraduate acquires some appreciation of the world as known by science, the Committee has set out what it considers should be aimed at in a course which is described as "Science for All". The list of subjects which is included in this course is very comprehensive and might perhaps be difficult to deal with in practice, but a strong case is made out for providing some such course.

Under the headings "Education for the Public Service", "Universities and the Education of Teachers" and "Universities and Adult Education" the report covers ground which has been explored by other committees which have recently published reports. The discussion on "World-wide University Collaboration" and the section on "Rehabilitation" gain special interest and importance from the assistance of distinguished academic members of the Allied Nations in their compilation.

In the section of the report which deals with university finance in Great Britain, we are glad to see the British Association putting forward suggestions which the universities themselves have been advocating for a long time, namely, an all-round improvement in the salaries of university teachers, the provision of residential accommodation for students of the newer universities on a much more extensive scale, an increase in the number of teaching officers and technicians on university staffs, and a much more generous expenditure than hitherto on facilities for research work.

On the question of salaries of members of university staffs the report emphasizes the present inadequacy of these in comparison with those ruling in other professions, and states that in the lower ranges they are, in some universities, insufficient to afford a reasonable standard of life under prevailing social conditions. The opinion is expressed that all whole-time professors in all English universities should be in receipt of "at least £1,500 a year at 1938 prices", and that certain subjects such as engineering and medicine should command salaries up to £2,500 per annum, it being assumed that some form of family allowance scheme will be in operation and applicable to all university personnel. The report, however, makes no suggestion that the salary attached to the headship of a department should, in general, depend upon the size of the department or on the amount of administrative work attached to the headship, nor does it point out that a higher salary scale for all grades of staff should prevail in London, where living expenses are greater than in the provinces—a fact usually recognized in the salaries of other professional persons.

According to the University Grants Committee's "Returns from Universities and University Colleges" for the years immediately preceding the present War, the expenditure on staff salaries formed about one half the total expenditure of universities, so that a general increase in salaries on the scale envisaged will require a large total increase in university incomes. The present total expenditure on staff salaries is about £3¾ millions per annum, and it appears that the increase needed immediately to bring salaries up to the desired level is not less than £1½ millions per annum, a sum which is about two thirds of the present annual parliamentary grant to universities and university colleges in Great Britain. The Association's report points out that, for the future, universities will inevitably have to look more and more to local and national grants for the needed increases in their resources, and it urges that the Treasury grant should at once be doubled after the War. The rough estimate made above shows that a doubled Treasury grant would need to be supplemented by considerably increased grants from local authorities if university education is to be made available to a greatly increased number of students, for this would involve an enlargement of existing staffs and increased maintenance charges for libraries, laboratories, and social amenities. In addition to increased recurrent grants for maintenance, most universities are urgently in need of large capital grants for the purchase of building sites and for the erection of additional accommodation for students' residences as well as for laboratories, lecture rooms and other buildings.

A novel suggestion in the financial part of the report is that money received by a university for services rendered should not be included in its annual income and expenditure account, but should be paid into a capital account, so that the finances of the institution should not be embarrassed when the services cease to be rendered and the income from this source comes to an end. The earnings mentioned in the report are those of certain medical and scientific departments, but the proposal might perhaps be extended to cover the net profits (if any) from external and school examinations.

Universities are rightly zealous in safeguarding their autonomy, and, in some quarters, fears have been expressed that increased Treasury grants might involve some form of Government control. The British Association Committee states that "the question of control by the Government is certain to be raised", but is of the opinion "that the universities will be strong enough to resist any harmful requirements which the Government might be tempted to couple with substantial increases in State grants". While holding strongly that university autonomy must be preserved, we believe that it would be advantageous to university education generally if a definite lead were given in regard to the directions in which expansion of university activities is most desirable. In the last few months all universities have submitted to the University Grants Committee their schemes for post-war development, and it is hoped that, in due course, large sums will be forthcoming to finance these. It is perhaps unlikely that the total cost of all the developments contemplated will be provided from Government sources, and it seems desirable that when a university is allotted a grant it should be informed which, if any, of the items in its programme are considered to be unnecessary in the national interest, and which are the particular developments in respect of which support is given.

The duties in connexion with the work of advising the Treasury in the distribution of the Government grant to universities have been carried out for twenty-five years by the University Grants Committee in a manner generally recognized as being altogether admirable, and which has won the full confidence and gratitude of the universities themselves. It surely merits much higher commendation than the somewhat grudging praise given in the British Association Report: "We are of the opinion that the University Grants Committee has done very well in the inter-war years".

The report stresses the desirability of the creation of a universities' advisory council, which should include the vice-chancellors of universities and the principals of university colleges, university teachers of various grades and persons of distinction in other walks of life. The council would have the duties of formulating a national policy of university education and research, of advising the universities on all the national and international aspects of British university problems, and of making representations to the official body which advises the Government on the financial needs of the universities. It seems to us that a committee so constituted would be unwieldy in size, difficult to assemble and unlikely to be able to function usefully in the directions suggested. Moreover, it would be redundant in view of the existence of the Committee of Vice-Chancellors and Principals, and of the Universities Bureau of the British Empire, which latter body will doubtless be considering whether any extension of the range of its activities is desirable having regard to the conditions which will prevail after the cessation of hostilities. The University Grants Committee has recently been reconstituted and enlarged. It has always been able to command such additional expert advice as it has needed from any academic or Government source. It is in constant touch with the Committee of Vice-Chancellors and Principals, which already fulfils some of the functions set forth above. Moreover, individual universities are often in consultation with Government departments on matters of national and international importance, and it is right that this direct consultation should continue.

One wonders whether those who are pressing for the establishment of a universities' advisory council are really aware of the many claims which are made on the time of a vice-chancellor or of other persons who are specially qualified to speak on university matters. It is important to guard against the danger of such an increase in the time occupied by attending meetings that those who regularly fulfil their duties in this respect become automatically less qualified to offer advice, because of their enforced detachment from their primary duties in their universities.

PROBLEMS OF MODERN PHYSICS*

By PROF. J. FRENKEL

THE War has shown up sharply the value of physics, and its achievements in the practical and in particular the military sphere. It is not in vain that from the moment the treacherous attack upon the U.S.S.R. began, the physics institutes of the U.S.S.R. (as of all combatant countries) were switched over, almost completely, to the solution of defence problems.

Although these problems are also basic problems of present-day physics, I shall not touch upon them at all here. My task is in brief to survey the 'normal' problems of modern physics, that is, those problems which physics sought to solve in peace-time, and to which it will return after the end of the War.

These problems can be divided into three groups:

(1) *Problems of theoretical physics.* These comprise, in the main, the explanation of phenomena which were discovered and studied experimentally some time ago. In a series of cases, however, theory has preceded experiment and predicted phenomena or laws which had been previously unknown. The most striking achievements of theoretical physics are among this type of prediction. It must be noted, however, that these predictions were in almost every case the outcome of a theory which aimed not at forecasting new, but at explaining old, phenomena. Outstanding theoretical workers have been able by this re-examination of old data to see in it features other than those which were thought to be known and understood.

A characteristic feature of any new theory, which does not try to fit new facts to an already established representation, but attempts a broader representation of the old as well as the new facts, is its irrationality from the point of view of previous ideas. This irrationality disappears only after these old ideas have been radically reconstructed. Striking examples of such 'revolutionary' theories in physics are Newton's theory of gravitation, Maxwell's electromagnetic theory of light (which predicted the existence of wireless waves), and the quantum theory of Planck, Einstein and Bohr.

(2) *Problems of experimental physics.* Here, as in the domain of theoretical physics, it is possible to distinguish two types, namely, the discovery of new things and phenomena (for example, X-rays, radioactivity, the neutron, the positron, etc.) and the detailed study of phenomena of which the general features only are already known. At first sight it would appear that we can discuss problems of the second kind only, because no one can know beforehand anything about phenomena which are still undiscovered. However, the conception of novelty allows a series of gradations, and if we have in view not only radically new phenomena, but also those which are in principle similar to ones observed previously, the search for such new phenomena can be included in a plan of scientific investigation.

(3) *Problems of technical physics.* Experimental physics is closely connected with theoretical physics on one hand and with technical physics on the other. In both cases this connexion has a two-sided character; that is, the respective parts of physics mutually condition and stimulate each other's development. In the realm of technical physics, we are concerned, generally speaking, with questions of utilizing the achievements of experimental physics for technical and, in particular, for industrial ends. In a number of cases, however, progress by technicians leads to the creation of new apparatus and methods of investigation, which open up new lines of development for experimental physics. Thus, for example, the development of radio-technics, which was the result of success in the study of electromagnetic and electronic phenomena, led in its turn to the creation of apparatus (electron counters, the electron microscope, the automatically operated Wilson chamber, the cyclotron) to which we are indebted for new knowledge in nuclear physics.

* Translated by E. R. Holmberg from *Vestnik Acad. Sci., U.S.S.R.*, 4–5 (1943), made available by courtesy of the Science Section of the Society for Cultural Relations with the U.S.S.R.

Physics of Material Bodies

A discussion of the problems of modern physics could be based on the classification introduced above. It is more convenient, however, to make a division into two groups of a different kind: problems of a macroscopic character connected with the properties of material bodies; and problems of a microscopic character, dealing with elementary processes and elementary particles of matter, and the nature of matter itself. The tasks and methods of theoretical, experimental and technical physics can be rigidly separated into the two groups under consideration.

The physics of the nineteenth century studied successfully the external side of phenomena, which was directly accessible to experiment and observation. The physics of the twentieth century successfully concentrated its attention on the internal mechanism of these macroscopic phenomena, that is, on their microscopic essence. In this way it had succeeded by the beginning of the 'thirties in explaining all phenomena in terms of the movement and mutual interaction of unchangeable elementary particles of two kinds, electrons and protons, in agreement with the general principles of quantum mechanics on one hand, and of electrodynamics on the other. As a result, it was possible either to establish theoretically and verify experimentally or to establish experimentally and explain theoretically, the structure and properties of those ninety-two kinds of atoms from which all material bodies known to us are constructed.

By the structure of atoms I have in mind the number, arrangement and movement of electrons around their respective nuclei, which for the majority of physico-chemical questions can be treated as positively charged point particles. Within the framework of this scheme, the structure of the atom was studied experimentally and theoretically with as much thoroughness as, for example, the structure of our planetary system.

New problems are connected with the deep study of the structure and properties of the atomic nucleus, and also with the process of its transformation—the alchemists' dream of artificial 'transmutation of atoms', now accomplished although only under laboratory conditions. From the other side these new problems are connected with the more detailed study of the system which depicts atoms in their combinations one with another—as molecules, crystals and amorphous bodies.

The development of atomic physics in each of these two directions has a completely distinctive character. In studying molecules and material bodies, physics is dealing with phenomena which have been studied experimentally, and in part theoretically, for many years, although from a more or less macroscopic and therefore inadequate point of view. The problems of modern physics in this domain consist principally of the theoretical explanation of accumulated facts, from a microscopic point of view, that is from the point of view of the modern picture of the structure of atoms and the behaviour of their constituent electrons and nuclei.

The application to these questions of quantum mechanics and electrodynamics had already led, if not to a quantitative then, in a large measure, to a qualitative explanation of the various phenomena. Modern physics has succeeded in laying the basis of quantum chemistry, and in determining the structure and properties not only of simple but also occasionally of complicated organic molecules and crystals. Here, in the majority of cases, physics has only confirmed or completed those ideas which were worked out earlier by chemists, at times just by feel, on the basis of indirect evidence.

It must not be thought, however, that all this progress was achieved in the realm of theoretical physics. X-rays and cathode rays (electrons) are powerful tools for experimental investigation into the structure of molecules and material bodies. But all the basic problems concerning the structure of systems more complicated than atoms, that is, consisting of several or many atoms, have a theoretical rather than an experimental character.

The modern theory of the structure of molecules and crystals is still very far from the stage of exactness which is achieved in the description of the structure of separate atoms. At the moment, there lies before physics the very wide (although perhaps not very profound) problem of the more quantitative development and clarification of our knowledge. Besides these structural problems, there lie beyond still further unsolved problems connected with the study of the processes which take place in molecules and material bodies under the influence of various factors, such as mechanical action, heat and cold, electric and magnetic fields, light, etc.

Problems of this kind by no means always need for their solution a detailed application of the ideas and methods of atomic investigation. In particular, this is true of problems concerned with the mechanical properties of solids and liquids (or more precisely of crystalline and amorphous bodies). Here can be observed a marked lagging of theory behind experiment and technical practice. It is sufficient to say that, until the present time, we have had no satisfactory theory of such well-known and practical phenomena as the friction of solid bodies; no quantitative theory of the plastic properties of crystals, that is, of their 'flow' under the action of sufficiently strong tension. Our ideas about the mechanical properties of solids and liquids have remained until the present time extremely simple and schematic.

Liquid bodies possess the properties of elasticity of volume, and viscosity under change of form. In recent times it has become apparent that liquids, besides having volume elasticity, also possess elasticity of form similar to a solid body; that is, besides plasticity, they possess rigidity, the latter being masked usually by the former. Further, a series of bodies has been studied which possess unusual properties, and which cannot be put into either of the traditional categories of liquids and solids. An example of these is resin, and other 'resinous' substances with a high elasticity which disappears at low temperatures, and also jelly-like liquids which have a wide application in the technics of to-day and possess completely individual elastic and plastic properties of structural origin.

The whole question of the 'unusual' mechanical properties of these substances, which are fortunately in most cases connected with their unusual electrical properties, is proof enough that a study of them from a theoretical as much as from an experimental point of view represents one of the tasks awaiting modern physics.

At temperatures near absolute zero, liquid helium occupies a certain peculiar position among these unusual substances. The striking experiments of Kapitza have shown that near the absolute zero of temperature helium completely loses the viscosity characteristic of normal liquids. As an explanation of Kapitza's experimental results, Landau has published an extremely interesting quantum treatment of the hydrodynamics of helium, based on the postulate that there exist two phases in liquid helium, a 'dead' non-viscous phase and a 'live' one possessing finite viscosity.

Landau's theory is in certain respects as unusual and 'irrational' as the experimental result it explains. But this is not sufficient to condemn it as a failure, because, as explained above, every new theory appears at first to be more or less irrational. However, the irrationality of a theory is not enough in itself to confirm its correctness. This can only be done by extending it to cover other phenomena, and then verifying its predictions experimentally (for example, in the case of liquid helium the proof of the theory is connected with the existence of two different velocities of sound in helium).

The absence of viscosity in liquid helium near the absolute zero of temperature is a mechanical analogue of the phenomenon of superconductivity, that is, the disappearance of electrical resistance, in a number of metallic bodies, at very low temperatures. Although this phenomenon has been known for some time, there is still to-day no satisfactory theoretical explanation of it, if we exclude certain attempted explanations of the fact that it occurs in two stages. The discovery of this explanation remains one of the real problems of modern physics, and in all probability it will need a basic alteration of our ideas concerning the normal conductivity of metals, along the lines of a more correct consideration of the mutual interaction between 'free' electrons, which condition this conductivity.

At the present time there is still great urgency about problems connected with the electrical, optical, photo-electric and thermo-electric properties of semiconductors of electricity, in spite of the great progress achieved in this sphere in recent years, particularly by Soviet workers such as A. F. Joffe and his school. These substances occupy an intermediate position between metals and dielectrics, just as liquids are intermediate between solids and gas-like bodies. As a rule, they become more like insulators at low temperatures and like metals at high temperatures. The effect of temperature is to produce ionization; that is, it tears off the bound electrons, which can then move freely throughout the whole crystal and thus conduct an electric current. Radiation also serves as an ionizing agent, not only in the visible but also in the infra-red region. Under the influence of unequal illumination or heating, appreciable photo-electric and thermo-electromotive forces arise in semiconductors.

At the present time, physics has to a large degree learned how to manage the various properties of semiconductors principally by the method of adding to them a mixture of atoms which either easily give up their own electrons or quickly capture foreign ones. The development of this new domain of physics has already produced results of enormous industrial and technical value, although the future promises still more important technical applications. Perhaps it will be semiconductors which will help mankind to solve a basic technical problem in the not distant future when the deposits of accessible fuel coal and oil are exhausted. I have in mind the problem of utilizing directly the sun's energy by converting it into electrical energy by means of photo- or thermo-elements. The preliminary results obtained before the War by A. F. Joffe and his fellow-workers show that this idea is not Utopian, because the efficiency of rationally constructed photo- and thermo-elements is very high (this efficiency is appreciably greater in the case of semiconductors than in that of metals).

But from the purely scientific point of view, the study of semiconductors is still far from complete, and there are a number of very interesting problems connected with the subject which are as much theoretical as experimental. Among these must be mentioned that of 'localized' but free electrons in a crystal lattice, undistorted except for these electrons. Connected with this is the question of the motion of slow electrons and the existence of 'excitons,' that is, freely movable centres of electron excitation. This last question has particular importance for the understanding of the mechanism of certain photo-chemical processes in crystalline dielectrics. It acquires special interest in connexion with a new method of testing insulators electrically, which was put forward recently by B. I. Davidov. According to this method of testing gases, ionization takes place in stages, that is, the ionized atoms are first excited (just as in excitation, the ionization is caused by collisions of atoms with electrons which were freed as a result of a previous ionization). This hypothesis seems very plausible to me, although it cannot be accepted without further quantitative experimental verification. In particular, however much the gas test resembles the test for solid dielectrics, Davidov's hypothesis postulates the existence of free electrons (that is, excited atoms) in these solid dielectrics.

The intermediate role of semiconductors is analogous to that played in magnetism by the so-called meta-magnetic bodies such as magnetite and also a large number of chemical compounds of magnetic with non-magnetic elements. At moderate temperatures these bodies behave like ordinary ferro-magnetics, but they lose their magnetic properties not only at high temperatures like ordinary ferro-magnetics but also at low temperatures. This as yet little studied phenomenon of 'meta-magnetism' has probably an important practical application besides its great scientific interest. In particular, there is great practical value in the further study of the problem of obtaining ferro-magnetic, or rather meta-magnetic, alloys from non-magnetic elements. At the present time, only a few such alloys are known, and they possess very interesting magnetic properties. It is interesting to note in this connexion that there is an analogy with superconductivity. We now know of a series of superconductors (at low temperatures) which are alloys of elements not themselves super-conductors.

The study of meta-magnetic phenomena requires the use of very low temperatures, although not so low as for the study of superconductivity, and the analogous problem of the disappearance of viscosity. These very low temperatures are also required for investigations into the optical properties of crystals, in particular for spectral analysis, and a large number of other properties of solid bodies which only become important in exceptional cases. Therefore one of the necessary subsidiary tasks of physics is to equip institutes with cryological laboratories and to improve further the methods of low-temperature work. (At the present time it is possible by magnetic methods to achieve temperatures of the order of one thousandth of a degree absolute.)

It must not be thought that interesting and little-known properties of solid bodies can only be demonstrated by means of super-low temperatures. In recent years there has accumulated a wealth of experimental material relating to transformations observed in crystalline bodies at medium and high temperatures. In contrast to ordinary allotropic or polymorphic transformations connected with changes in crystal structure and the emission or absorption of heat, 'transformations of the second kind' about which I am thinking only make themselves apparent by anomalous changes, over a fairly narrow interval, in specific heat, coefficient of expansion and a series of mechanical, electrical, magnetic and optical properties.

Similar transformations were first established by observations in the case of ferromagnetic bodies near the so-called Curie point, above which their ferro-magnetism disappears. This is a phenomenon similar in character to the disappearance of superconductivity at low temperature, that is, the restoration of normal electrical conductivity, and to the transition of liquid helium from its anom lous modification II having no viscosity to the normal phase, helium I, with a finite viscosity.

Analogous transformations of the second kind were recently brought to light in certain metallic alloys. As was first shown by Bragg and Williamson, these transformations occur when the regularity of the relative positions of the different kinds of atoms breaks down. Thus, for example, in an alloy of zinc and copper in equal proportions, the atoms are arranged in a chessboard pattern at low temperatures, but at a transformation at a certain temperature analogous to the Curie temperature in ferro-magnetics this alternating arrangement completely disappears.

Further, a series of crystalline substances is known, for example, compounds of halogens with hydrogen, methane and other paraffins, in which these second order transformations can be traced—wholly or in part—to disordering of the particles (or as Pauling thinks, in certain cases to the molecules changing over from oscillatory motion about regularly distributed equilibrium positions to free motion as in gases). These analogies do not, however, cover all the observed phenomena. Thus, for example, in the case of hydrogen chloride, one Curie point is observed which can be attributed to the molecules becoming disordered (or according to Pauling, to the transition to free motion) ; but in the case of hydrogen bromide, there are three such transformations.

Thus we can see that the experimental and theoretical study of second order transformations in crystalline bodies represents for modern physics a wide and as yet far from exhausted problem.

The formulation of a theory of the liquid state is a wide and urgent problem for theoretical physics.

Early attempts at a solution of this problem used the kinetic theory of gases and treated liquids as highly compressed gases. In more recent times the tendency has been to liken liquids more to solid bodies, lacking the greater orderliness in the arrangement of their particles, but still possessing that close packing which characterizes the crystalline type of structure. Since the liquid state is intermediate between the solid and gaseous states, it is natural to expect that the similarity between liquids and compressed gases becomes more or less exact at high temperatures (close to the critical temperature) and that at temperatures near crystallization liquids resemble solids. This kind of description, borrowing from the kinetic theory of gases on one hand and from the kinetic theory of crystals on the other, is, however, only an interpolation, having a limited value. There are sceptics who think that, in view of the great complexity of the problem, physics is only handicapping itself in explaining the structure and properties of liquids by such interpolations. Personally, I consider, however, that this scepticism is unjustified, and that further work towards perfecting the kinetic theory of liquids is one of the real tasks of physics in our time.

It must be mentioned that the performance of this task leads immediately to the necessity of radically altering our traditional ideas about the fluid state of bodies, first of all with the aim of removing the contradiction between the concept of plasticity and rigidity. As already explained above, the first of these does not exclude the second but only masks it. It is necessary, moreover, to bear in mind that the division of bodies, or rather aggregate states of substances, into solids and liquids does not accord with reality, which provides an extremely complex profusion of such states. Besides the liquid-crystalline (or mesomorphic) state which has already been studied thoroughly from the experimental side, modern physics knows of states which it is impossible to fit into the 'solid and liquid' scheme ; for example, the resinous state, which as shown by very recent investigations can be encountered in such simple substances as sulphur and phosphorus. To phenomena such as these must be added the various jelly-like states which have hitherto scarcely been studied. But among those to whom the study of jelly-like systems (gels) presents enormous interest are the biologists, for recently physics has begun to penetrate into their sphere through the peculiar intermediate science of biophysics. So we see that one of the fundamental problems of modern physics is the experimental study of complex aggregate states and the construction of a molecular-kinetic theory for them.

The development of all natural sciences is closely bound up with the improvement of the apparatus with which natural phenomena are observed and which produces phenomena not encountered under natural conditions. In this respect physics differs from other sciences, for it creates new apparatus in connexion with new methods, not only for other sciences but also and in the first place for itself.

We have already mentioned above the remarkable phenomena of superconductivity and the disappearance of viscosity, which were discovered through working out methods of achieving very low temperatures. In this direction—the approach to absolute zero—physics has still, apparently, not reached finality ; a number of properties of material bodies connected with the magnetic moments of nuclei need for their experimental observation and study still lower temperatures—of the order of one ten-thousandth part of a degree and lower. Physics has the means with which to do this (by using the magnetic moments of atoms and nuclei) but has still to use them fully. This is work for the near future.

In the region of high temperatures, modern physics has still not progressed very far. The maximum temperature achieved in the laboratory is somewhere around 20,000°, although as yet it has not been possible to observe the properties of any bodies at this temperature. In this respect more interesting results have been produced by astrophysics.

In recent times extremely important results have been obtained in high-pressure work. A few years ago, Bridgman succeeded in producing pressures up to 50,000 atmospheres, and further was able to study their effect on a series of properties of solids. More recently still, it has been possible to raise this limit to around 100,000 atmospheres, that is, approaching the order of pressures (about one million atmospheres) which prevail at the centre of the earth. One of the urgent tasks of experimental physics is to study further the properties of matter at these extreme pressures.

Besides these achievements in the realm of super-high pressures and super-low temperatures, physics has in recent years much increased the power of its observations by creating and applying the electron-microscope. Ordinary microscopes give a magnification not exceeding five to six thousand times. With the help of the electron-microscope it has been possible to increase this limit a thousand-fold, that is, to reach a linear magnification of the order of one million. The application of the electron-microscope has already produced a number of remarkable results in physics, metallography, colloidal chemistry and in particular in biology, for it has made possible the observation of individual 'molecules' of certain pathogenic viruses ; apparently these molecules are able to grow and multiply, and represent forms intermediate between ordinary crystals and living organisms. The study of the new 'ultra-microscopic world' discovered by the electron-microscope will in the near future be one of the most important and fruitful tasks of so-called higher science. At every stage it brings forth new discoveries and sheds light on phenomena which were known before only incompletely. In this the electron-microscope will play as great a part as did the ordinary microscope in its time. A whole series of objects ranging from those of microscopic size of linear dimensions of the order 10^{-4} cm. down to particles not much larger than molecules now becomes accessible to direct observation and investigation. This is the domain which is of immediate interest for the sciences both of living and dead material.

Finally, there is still one more branch of physics which seems likely to make noteworthy progress. I am referring to the increases in frequency of artificially produced electrical and mechanical vibrations (ultra-short radio waves and ultra-sonic waves). Modern radio technics has succeeded in producing frequencies of the order of 10^9 per second, which correspond to electromagnetic waves with a wave-length of less than 1 cm. However, between these radio waves and those of infra-red heat, there still remains the practically unexplored interval of wave-lengths ranging from some millimetres to a tenth part of a millimetre. But it is just this interval which is so interesting for the study of the electrical properties of liquid and solid dielectrics (for example, absorption and dispersion should be very large). This interval of frequencies also presents great interest for the study of the mechanical properties of solids and more particularly liquids. This can be done by investigating the propagation through them of artificially produced ultra-sonic or hyper-sonic vibrations the frequency of which approaches that of their heat movements. The process of transforming electrical into mechanical vibrations has already been worked out; what remains is to increase further the frequency of radio-waves. During the last three or four years there has opened up a new way of attacking this interesting and important work by the use of klystrons and other electronic apparatus.

Summarizing, we see that the most interesting problems in physics are those connected either with limiting or with intermediate properties of material bodies. This conclusion holds also for other sciences besides physics, and further, the most topical problems are concerned not with those phenomena which are studied by definite specialized sciences, but with those borderline phenomena which fall between them. It is thus perfectly natural that these problems, besides being the most complicated, are also the least studied. A particular example of this is biophysics, the problems of which have been intensively studied by physicists for some time. In recent years, physics has attracted biologists to help in the solution of these biophysical problems, but physicists have not themselves shown much interest (if we except the physiological aspects of optics and acoustics). I am inclined to think that in the very near future this position must undergo a definite change, and that this part of the science front must conduct an extensive battle for new knowledge. I shall not attempt to enumerate the problems of biophysics because they are innumerable. Besides problems about the properties of gels mentioned above, there are those concerning photosynthesis, nervous and mental activity and electro-physiology (in particular, electrical vibrations in the brain). Finally, not the least interesting problem is that of the mechanics of living organisms (for example, the locomotion of animals and insects).

Not long ago, physical chemistry occupied the intermediate position which is now occupied by biophysics. At the present time, the formerly borderline phenomena have been completely assimilated into physics.

In its impetuous rush of growth, physics has of course been unable to prevent itself encroaching on the region long considered the province of chemistry. In distinction from chemistry, which is a science of materials and their transformations, physics, like sciences of other phenomena connected with matter, has lost this sense, by 'going behind' chemistry in discovering the structure of the chemical atom-elements and showing how to cause their artificial transmutation. In this way, chemistry has become a branch of physics, though it is true one of the largest, most interesting and practically the most important branch. In an exposition of the problems of modern physics, it would therefore be quite appropriate to include also the basic problems of chemistry. I shall, however, leave those problems which belong to chemistry in its narrow sense and pass on to those of the modern 'alchemy' which concern the atomic nucleus.

(To be continued.)

OBITUARIES

Dr. W. A. K. Christie

HIS numerous friends will receive with the greatest regret the news of the unexpected death of Dr. William Alexander Kynoch Christie, which took place in London on June 16, after a very short illness.

Christie was the youngest son of Charles Robert Christie and Margaret Catherine Paterson, both of Edinburgh, where he was born on October 2, 1882. He was educated at Daniel Stewart's College and Heriot's, Edinburgh, and then in succession at the Universities of Edinburgh and Zurich, where he took the degrees of B.Sc. "with special distinction in chemistry", and Ph.D. respectively.

After acting as Prof. Crum Brown's private assistant, Christie went to the Mond Nickel Co. in South Wales, until he was appointed to the staff of the Geological Survey of India to fill the newly created post of chemist to the Department. He took up his appointment in Calcutta on November 17, 1906. This he held until his retirement from the service on October 10, 1932, after a service of nearly twenty-six years, of which slightly more than five years was spent away from the Department. Of this, nearly two and a half years was during the War of 1914–18 in the Indian Army Reserve of Officers, from which Christie was drafted to the Special Reserve of the Royal Engineers in France, where his chemical knowledge was used in the service of his country.

With other officers of the Geological Survey who had gone to the War he was recalled in 1917, owing to the growing realization of the need of geologists and chemists to help in the production of war minerals. In April 1918 Dr. Christie's services were placed at the disposal of the Government of India in the Finance Department, whereon he was posted to His Majesty's Mint, Calcutta, as deputy assay master, later acting as assay master. He reverted to his post in the Geological Survey at the end of 1920.

In 1936, after a few years in retirement in England, Dr. Christie was again employed by the Government of India, this time as civilian technical officer in the Principal Supply Officer's Committee (India) under the Defence Department, India. He was in England on deputation at the outbreak of war in 1939 and was retained at the India Office, where he was still described as a civilian technical officer, a post he held until his death. In 1930 Christie married Miss Winifred Davidson, who survives him.

Christie's scientific activities were not confined to his official appointments, as is shown by the fact that he was a fellow of the Royal Institute of Chemistry, a member of the Institution of Mining and Metallurgy, a fellow and, in 1927, president of the Asiatic Society of Bengal.

Christie was one of those specially useful men of science who are qualified in two sciences, in his case chemistry and geology. While his chemical knowledge took priority and justified his various employments outside the Department, his wide knowledge of geology and mineralogy made him a valuable member of the Geological Survey of India, as he was often able to offer sound advice both to individual officers and to his director on problems involving both chemical and geological knowledge. With this scientific versatility Christie combined a proficient knowledge of French and German, both spoken and written, and an interest in the literature of both countries.

An additional facet of this versatility was Christie's wide knowledge of, and sympathy for, his fellow men. Not only did these qualities cause him to give help unobtrusively to 'lame ducks' both inside and outside the department—no one ever asked his help in vain—but it also caused successive directors of the Survey to value his opinion on matters not strictly chemical or geological. They also made him a valued member of club committees (the Bengal United Services Club, Calcutta, of which he was at one time president, and the East India and Sports Club in London). Everyone who knew Christie will remember his ready wit and mastery of apt phrase. As an example one may recall that on one occasion the late H. S. Bion, very early in his service, telegraphed from the field that he had at last discovered calcareous algæ in the Lower Eocene of Burma. Christie suggested that the director should reply "The whole Department shares your ecstatic joy".

As chemist to the Geological Survey of India much of Christie's time was used on routine work and work for other officers; but on all occasions where ingenuity was needed he proved to be a prince of experimenters, the accuracy of whose work could be trusted to the last recorded decimal.

The total amount of work published from Christie's pen is small, but it is of the highest quality. His greatest achievement was the sampling of the winds of the Rajputana desert during the hottest season of the year, when shade temperatures up to 120° F. and more are registered. The then director of the Geological Survey, now Sir Thomas Holland, had instituted a detailed study of the salt reserves of Rajputana, particularly of Sambhar Lake. He had decided that a probable explanation of this large accumulation of saline materials was carriage by hot-weather winds from the salt-encrusted arm of the sea known as the Runn of Cutch. Christie volunteered to test this hypothesis and went to Pachbadra (intermediate between the Runn of Cutch and Sambhar), where he was aided by the late Rao Bahadur M. Vinayak Rao. All Christie's instrumental ability was brought into play, and, using methods that he had first worked out and apparatus that he had designed and tested in the laboratory in Calcutta, he sampled the wind at Pachbadra during April–July 1908. As a result he was able to show that during the hot weather of that year the amount of sodium chloride in the form of fine dry dust coming from the south-south-west that passed a front 300 km. broad and 100 m. high during the four hot-weather months might be indicated as 130,000 tons. This was in a year when the hot weather winds were unusually weak, so that this figure is probably well below the annual average influx of salt dust. The results of this study are discussed in a joint paper by Holland and Christie (*Rec. Geol. Surv. Ind.*, 38, 154; 1909).

Christie also visited and discussed the soda lake of Lonar in Berar, and the well-known salt deposits of the Salt Range, in the latter case studying specially the potassic layers.

Another investigation of some interest was of a white efflorescence collected by me at the fissured surface of the Barari colliery, Jharia, then on fire underground. The mineral proved to be cryptohalite, a fluo-silicate of ammonium previously found only at a Vesuvian fumarole; its occurrence, with native sulphur, recalled the long-abandoned hypothesis that volcanoes owed their activity to the combustion of coal underground (*Rec. Geol. Surv. Ind.*, 59, 16, 233; 1926).

L. L. FERMOR.

Sir John Jarmay, K.B.E.

THE death of Sir John Gustav Jarmay on August 22 at the age of eighty-seven probably removes the last of those heroic figures who, with Ludwig Mond and John Brunner, struggled to found the ammonia soda industry in Great Britain and in the end established our greatest and most successful chemical industry. A Hungarian by birth, he studied at Zurich and came to England in 1875, working for a short time with Roscoe before he obtained a junior position with Greenall Whitley, the Warrington brewers. Ludwig Mond, who lived at first outside Widnes and later at Winnington, must have come across him and brought him in to help in 1877, four years after the start. It is a pity that no one has put these early days on record, days of continuous effort round the clock, of many failures and difficulties and always the courage of Ludwig and Frieda Mond to try again. Another helper was Carl Markel, tutor to Robert and Alfred Mond, a swarthy Stuttgarter of great originality. Jarmay made good and was chief technical manager when Brunner Mond was formed as a company: eight years later he joined the board of the company.

The expansion was rapid, but the technical progress was veiled in reticence and only through patents, many of which bore Jarmay's name, could the outside world glimpse what was happening. Close contact was kept with Solvays at Brussels, and there were developments in the United States and elsewhere, but the real hub of alkali progress was at Winnington. There Jarmay reigned and led a loyal and expanding team. When Ludwig Mond died in 1909, Jarmay took on added responsibility, and he continued to hold the reins firmly until the formation of Imperial Chemical Industries, Ltd.

Naturally he was one of the first consulted by Lord Moulton in 1915, and assumed responsibility for the production of nitrate of ammonia, T.N.T. and phenol. He achieved much and was recognized by the award of the K.B.E.: about the same time the war services of his wife earned her the D.B.E.

It is to Jarmay's credit that the need to establish nitrogen fixation plant in Great Britain was recognized as one which Brunner Mond were in honour bound to study, though it was a task outside their normal business and bound to be arduous and costly. The great works at Billingham and elsewhere to-day are a monument to his wise decision.

Jarmay was married in 1882 to Charlotte Elizabeth Wyman, a lady of great charm, who was of the utmost assistance to him: she made their house at Hartford Lodge the social centre of the staff. She died in 1938.

Jarmay the man looked an aristocrat to the finger-tips. He hunted a good deal and was noted for his immaculate appearance in the hunting field—locally he was affectionately known as "The Squire". He spent his holidays abroad, being never more happy than when among the mountains and snowfields. On his retirement he lived in Italy until the outbreak of war.

E. F. ARMSTRONG.

Mr. Henry W. J. Hathaway

HENRY WILLIAM JOHN HATHAWAY, who was killed accidentally on July 4, was born in London on October 27, 1915. He was educated at the Polytechnic School, Regent Street, London, and at the Imperial College of Science and Technology, South Kensington, where he read chemistry and geology, and took his B.Sc.

(Honours) in 1939, as a result of which he was granted his A.R.C.S.

Hathaway first held an appointment with Messrs. Murex Welding Co., Ltd., towards the end of 1939, working on the technology of tungsten. In January 1940 he joined the Fullers' Earth Union Ltd., Redhill, Surrey, as works chemist. Here he had full scope for his ingenuity in the development of chemical engineering processes. For many months he worked on an effluent treatment plant, assisting in its design, erection and eventual working, and carried out research into the utilization of the gel-like product. He worked hard to increase his theoretical knowledge of chemical engineering, and showed a remarkable flair for imbuing workmen with interest and enthusiasm. He could undertake almost any plant operation with his own hands, and was adept at making laboratory apparatus.

In July 1943 he joined Messrs. Bound Brook Bearings (G.B.), Ltd., Birmingham, where, as chief chemist, he supervised the installation and starting up of a new experimental laboratory. After a period as assistant to the works manager, helping on production problems, he began a comprehensive programme of experimental work on powdered metals. He took an active interest in the social side of works life.

Hathaway tried his hand at everything; he had a great thirst for experience. He was impatient with unnecessary delays and detested waste in factories or slackness in men. His creative urge, versatile hands and wide general knowledge would have carried him far, and industry has lost an unusually promising young life. He had been married only three months and is survived by his widow and his parents, of whom he was the only son.

Robert H. S. Robertson.

We regret to announce the following deaths:

Prof. Harry Berman, associate professor of mineralogy at Harvard University, on August 28, aged forty-two.

Mr. H. P. Marks, a member of the scientific staff of the National Institute for Medical Research for the past seventeen years, on September 13.

Sir Humphry Rolleston, Bt., G.C.V.O., K.C.B., during 1925–32 regius professor of physic in the University of Cambridge, on September 24, aged eighty-two.

Mr. W. H. Ross, O.B.E., formerly managing director and chairman of the Distillers Company, Ltd., and founder of the Ross Research Foundation for the Study and Prevention of Blindness, Edinburgh, on August 22, aged eighty-two.

NEWS and VIEWS

Mr. T. Raymont

Mr. T. Raymont, the well-known educationist, celebrated his eightieth birthday on September 27. at his home in Carbis Bay, Cornwall. As an educationist, Mr. Raymont began his career in the chair of education in University College, Cardiff, in 1890, where he remained until 1905. He was then appointed vice-principal and later warden of Goldsmith's College (University of London), where he remained until 1927. There Mr. Raymont did some splendid work in the development of that College. During the difficult times of the War of 1914–18, he saved the College from extinction by his perseverance and common sense and above all by his absolute faith in its future. By his personal efforts he secured its survival and development in a greatly extended form as a training college for all branches of education. During that time, therefore, his reputation in the educational world became wholly established and his advice was keenly sought after. He was educational adviser to the National Froebel Union for eight years, besides being chairman for an even longer period. In 1928 he was president of the Training College Association and also of the Froebel Society. Perhaps Mr. Raymont's most well-known publication was "Principles of Education", which first appeared in 1904 and became a standard work that has passed through a large number of editions, the latest of which is still in demand. Other publications were "The Use of the Bible in Education", "Modern Education", and "The History of Education in Young Children". For many years Mr. Raymont has written in the educational journals. He has also been a regular contributor to *Nature*, and still is.

One of Mr. Raymont's daughters, who was formerly on the scientific staff of the Wellcome Historical Medical Museum, is the wife of Mr. H. J. Braunholtz, keeper of oriental antiquities and ethnography in the British Museum, and a past president of the Royal Anthropological Institute. Mr. Raymont's educational interests are shared also by Mrs. Raymont and two other daughters, all of whom have taught or are teaching in schools. We are glad to record that Mr. Raymont is enjoying excellent health, and still keeps in close touch with the general progress in education and science. The War has unfortunately interrupted his visits to London; but, in addition to his literary work, he finds a fruitful outlet for his energies in local educational affairs and in serving on the committee of the Penzance Library. We offer our congratulations to Mr. Raymont, and hope that for many years to come he will live to enjoy a very active life and continue to give educationists and men of science the benefit of his very wide knowledge and long experience.

Chair of Zoology at Bristol

Prof. J. E. Harris, who succeeds Prof. C. M. Yonge in the chair of zoology at Bristol, has for some years been a University demonstrator in zoology at Cambridge. He is well known for his versatile contributions to experimental zoology, among which perhaps the most noteworthy is his analysis of the functions of the paired and unpaired fins of fishes. He has, however, also made highly original contributions to the physical properties of living cells, which may be expected to lead to results of widespread significance. Most of Prof. Harris's work has been carried out in Great Britain, but prior to the War he spent two years in the United States as a Commonwealth Fellow. For the past three years he has been in charge of a research unit under the Iron and Steel Institute. Prof. Harris may be expected to exploit to the full the admirable facilities which the University of Bristol has provided, in recent years, for the study of experimental zoology. The appointment of a man of Prof. Harris's wide interests and experience may be regarded not only as a source of satisfaction to the University of Bristol, but also as a good augury for the post-war development of zoology in Great Britain.

Chinese Professors Visiting Britain

FIVE Chinese professors have just arrived in Britain, and will be guests of certain colleges at Oxford and Cambridge and of the British Council. They will continue their studies with the view of making British achievements in these fields better known in China. The visitors are: Prof. Chang Tsu-Kung, of the Central China University, an authority on the history of science, who is going to Christ's College, Cambridge; Prof. Yin Hung-Chang, of the Associated South-Western Universities (Tsing Hua), Kumming, who will do research in plant biochemistry, and will reside at St. John's College, Cambridge; Prof. Chang Hui-Wen, of the Central University of China, where he taught public administration and political science, who is to study public administration in Britain in connexion with the development of the Civil Service examination system in China, and will be attached to Corpus Christi College, Cambridge; Prof. Fan Tsen-Chung, head of the Foreign Languages Department, National Central University, Shapingpa, who will undertake research in English literature (with special reference to English knowledge of China), and will reside in Balliol College, Oxford; Prof. R. C. Fang, head of the Foreign Languages Department, Wuhan University, Kiating, who will undertake research in English literature, and will reside in Trinity College, Cambridge.

French Scientific Mission in Great Britain

THE executive committee of the Society for Visiting Scientists received the members of the French Scientific Mission on September 16 at the Society's house at 5 Old Burlington Street, London, W.1. Prof. F. G. Donnan expressed a warm welcome to the Mission, which is led by M. L. Rapkine, and includes Prof. J. Hadamard, Prof. Pierre Auger, Prof. Francis Perrin and Dr. R. Wurmser. He said that French civilization and science are an essential part of those of Europe, and, as Voltaire might have said, if they did not exist, it would be necessary to invent them. He hoped that Anglo-French scientific relations will grow at a great pace and become one of the foundations of development in the post-war period. Sir Henry Dale supported Prof. Donnan, and looked forward with particular pleasure to the prospect in the near future of Prof. Hadamard being officially admitted as a foreign member of the Royal Society.

Research in Cotton Growing

AT a meeting of the Administrative Council of the Empire Cotton Growing Corporation on June 6 several new appointments were made. Mr. Arthur Foster was elected chairman of the Council in succession to the late Sir Richard Jackson and Mr. James Littlewood vice-chairman. The post of director of the Corporation was filled by Mr. L. G. Killby, and Mr. J. C. May was elected secretary. Mr. Killby has also been appointed chairman of the Scientific Committee. The activities of this body have largely been concerned with the arrangements for establishing the new Central Cotton Research Station in Uganda. Though actual building operations cannot begin until after the War, a satisfactory site has been selected, and it is hoped that some preliminary work on it will soon be started. Mr. Parnell and Mr. Hutchinson have been designated for the posts of director and deputy director of the new Station respectively.

The Corporation's report for 1942–43, together with the programmes of work for 1943–44 of each of its seventeen experiment stations, has been submitted in the same form as in previous war years, and can be obtained, price 3*s*., from 37 Inner Park Road, Wimbledon Common, London, S.W.19. The research station in Trinidad is being closed in order that work may be concentrated in the larger cotton-growing countries with the new Station at Uganda as a central feature. This attention to development in research was commended by the President of the Board of Trade in his message to the Corporation at its annual general meeting for, as he said, efforts to improve the quality of cotton grown in the Empire and to increase its yield per acre is a valuable contribution to the prosperity of the Empire as a whole.

Town and Country Planning

IN view of the important part which engineers are playing and must play in all future planning, the Council of the Institution of Civil Engineers has appointed an Institution Committee to be known as "The Town and Country Planning Committee" to advise the Council on matters relating to the engineer's part in town and country planning. This takes the place of a sub-committee of the Public Relations Committee, which had been dealing with this matter previously. The new Committee will include members who are city engineers and borough surveyors and others who have specialized on roads, railways, docks, water supply, drainage including sewage disposal, and electricity and gas services.

In order to enable engineers and others to keep in touch with present-day principles and ideas in planning, the Council has also arranged a series of four lectures on "The Position of the Engineer in Relation to Town and Regional Planning" on Thursdays at 5 p.m., beginning on October 26. Particulars of the lectures are as follows: October 26, "The Basis of Town and Country Planning", by Mr. H. J. B. Manzoni, city engineer and surveyor, Birmingham; November 2, "Traffic Problems", by Mr. W. S. Cameron, city engineer and surveyor, Leeds; November 9, "Drainage, including River Works", by Mr. D. G. Bevan, deputy city engineer and surveyor, Birmingham; November 16, "Services (Electricity, Water, Gas and Post Office)", by Mr. J. Paton Watson, city engineer and surveyor, Plymouth. These lectures will be open to non-members of the Institution on payment of 2*s*. 6*d*. for each lecture. Applications for tickets, accompanied by remittances, should be made to the Secretary of the Institution.

Rickettsia Diseases

THE March issue of the *Boletín de la Oficina Sanitaria Panamericana* contains reports concerning Rocky Mountain spotted fever and the typhus group from five members of the Panamerican Sanitary Bureau Committee on Typhus, namely, Dr. Otávio de Magalhães of Brazil, Dr. L. Pātino-Camago of Colombia, Dr. A. Recco of Cuba, Dr. C. G. Hidalgo of Ecuador and Dr. G. Varela of Mexico. There were, in all, 791 cases of Rocky Mountain spotted fever and 9,625 cases of the typhus group. Brazil reported 663 cases of spotted fever in the fourteen years 1929–42, occurring in thirty-six localities of three States (Rio de Janeiro, Minas Gerais and São Paulo), but the report was admittedly incomplete and consisted only of the severe forms of the disease. In Columbia there were 128 cases of Rocky Mountain spotted fever during 1934–43 in seven localities in two departments. With regard to typhus fever (type not specified), except for Cuba where all the cases were of the murine type, Brazil reported four cases in 1941, Colombia 882 cases in 1942 and the first quarter of 1943 with a case fatality of 10–17·4 per cent in hospital cases. In Mexico there were 8,198 cases of typhus during 1938–42, with 750 in Mexico City, and a case mortality of 14 per cent. In Ecuador there were 517 cases of Rocky Mountain fever and 18 of typhus.

Fulgence Raymond (1844–1910)

PROF. FULGENCE RAYMOND, a leading Paris neurologist, was born on September 29, 1844, at St. Christophe, Indre et Loire. He first studied veterinary medicine at the School at Alfort, where in 1867 he became director of the department of anatomy and physiology. Afterwards he took up medicine in the Paris faculty under Vulpian and Charcot and qualified in 1876. In 1894 he succeeded Charcot in his hospital practice and in the chair of nervous diseases at La Salpêtrière.

Raymond was well known in Great Britain, where he was made an honorary D.Sc. at Oxford and delivered a lecture at the Royal College of Physicians on "Premature Physiological Senescence localized to certain Organic Systems". He died on September 28, 1910. His chief publications were "Anatomie pathologique du systême nerveux" (1886), "Maladies du systême nerveux" (1889–94) and in collaboration with Janet "Leçons sur les maladies du systême nerveux", "Neuroses et idées fixes" (1898), "Obsessions et la psychasthenic" (1903), "Etudes de pathologie nerveuse" (1910). He also made numerous contributions to the *Revue Neurologique* and *L'Encéphale*.

Appointments in the University of London

DR. C. A. MACE, University reader in psychology at Bedford College, has been appointed as from October 1 to the University chair of psychology tenable at Birkbeck College.

Prof. W. H. McCrea, since 1936 professor of mathematics at Queen's University, Belfast, and since 1943 temporary principal experimental officer in the Admiralty, has been appointed as from October 1 to the University chair of mathematics tenable at Royal Holloway College.

Prof. Frank Goldby, since 1937 Elder professor of anatomy in the University of Adelaide, has accepted the appointment to the University chair of anatomy tenable at St. Mary's Hospital Medical School, and hopes to take up his post during the session 1945.

Tapeworms in Seagulls and Cormorants

REFERRING to the report by J. B. Duguid and E. M. Sheppard of the infection of trout in a South Wales reservoir with plerocercoids of a tapeworm belonging to the Diphyllobothriidæ (see *Nature* of August 5, p. 185), M. D. Hickey and J. R. Harris (*British Med. J.*, 310, Sept. 2, 1944) report the finding of an adult tapeworm belonging to the genus Diphyllobothrium in seagulls and cormorants in the Dublin area. They think that these birds are the naturally infected definitive hosts of the parasite in this district. Trout from reservoirs near Dublin are heavily infected with plerocercoids belonging to the Diphyllobothriidæ. In the intestines of the greater and lesser black-backed gulls (*Larus marinus* and *L. fuscus*), of herring gulls (*Larus argentatus*) and of cormorants (*Phalacrocorax carbo*) the authors found all stages of the tapeworm from the plerocercoid found in the fish to the adult tapeworm. Investigation is proceeding and further details will be published later.

The Night Sky in October

FULL moon occurs on Oct. 2d. 04h. 22m. U.T., and new moon on Oct. 17d. 05h. 35m. The following conjunctions with the moon take place: Oct. 8d. 16h., Saturn 0·3° N.; Oct. 14d. 01h., Jupiter 3° S.; Oct. 19d. 20h., Venus 5° S. The following occultations of stars brighter than magnitude 6 take place: Oct. 4d. 0h. 18·4m., ξ^2Ceti (*D*); Oct. 4d. 0h. 47·9m., ξ^2Ceti (*R*); Oct. 6d. 1h. 57·0m., 64 Tauri (*R*). The times refer to the latitude of Greenwich and *D* and *R* refer to disappearance and reappearance respectively. Mercury rises at 4h. 38m. at the beginning of the month and is in superior conjunction on Oct. 20. At the end of the month the planet sets very shortly after the sun. Venus sets at 18h. 22m. and 17h. 46m. at the beginning and end of the month respectively. Mars is too close to the sun for favourable observation. Jupiter, in the constellation of Leo, rises at 3h. 48m., 3h. 8m., and 2h. 22m., at the beginning, middle and end of the month respectively. Saturn, in the constellation of Gemini, sets at 14h. 09m., 13h. 16m., and 12h. 13m. at the beginning, middle and end of the month respectively. The Orionid meteors should be seen during October 18–26.

Announcements

THE Committee of Privy Council for Medical Research has appointed Dr. Alan N. Drury (director of the Lister Institute of Preventive Medicine) and Prof. James C. Spence (professor of child health in the University of Durham and honorary physician to the Royal Victoria Infirmary, Newcastle-upon-Tyne) to be members of the Medical Research Council as from October 1.

THE Royal Aeronautical Society is arranging a discussion on civil aviation to be held on November 4 at the Institution of Mechanical Engineers. The discussion, which will begin at 10.30 a.m. and continue throughout the day, will be divided into sections dealing with economics, aircraft and aero engine design, route facilities (meteorology, radio, aerodromes, etc.) and the selection and training of personnel. The chair will be taken by Lord Brabazon. Tickets of admission will be available only through members of the Royal Aeronautical Society.

ERRATUM. In the communication "Standardization of Root Excretions . . ." by Dr. C. Ellenby in *Nature* of September 16, p. 363, for "a second sample is taken" read "the second oxygen determination is made".

LETTERS TO THE EDITORS

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

The Magnetic Current

IN an article in *Nature* of February 5, 1944, entitled "Magnetic Current", Mr. James T. Kendall deals with movements of dia- or para-magnetic liquids in non-homogeneous magnetic fields, combined with electro-dynamic rotations. He states that his horizontal magnetic field is not uniform (non-homogeneous) and observes the mass movement of the liquid as disclosed by refractive index striation without making use of the dark field of a microscope.

I am using vertical magnetic and electric fields of the highest homogeneity, separately and combined, so as to make those fields coincide with the gravitational field[1]. The two vertical cylindrical pole pieces, 6–12 mm. in diameter, have been adjusted so that their opposing circular faces are exactly horizontal and parallel, and the distance separating them can be regulated. In and around the space between these two pole faces (0·5–2 mm. apart) the movement of single microscopic particles in gases or particles and bubbles in liquids can be observed in the dark field of a microscope with low or high aperture. It is self-evident that observation with more sensitive means discloses new facts, permitting measurements of forces down to 8×10^{-11} dynes. Those forces are measured by comparing them with the gravitational force exerted upon the single particle[2,12].

The essential facts proving the existence of the magnetic current are the following. (1) Polar movement of single particles to the north or to the south in a homogeneous magnetic field in gases, reversing their direction with the reversal of the field, their velocity depending on the field strength. The Peregrinus experiment of A.D. 1269 leads to a positive result when repeated with sensitive means. The above observation[3] leads to the concept of the magnetic ion, counterpart to the electric ion. Magnetic ions, north or south, can be produced by friction, by chemical means or by irradiation, as it is well known for electric ions. I have observed also magnetophoresis[4], the counterpart to electrophoresis (Reuss, 1809), as well as coagulation of matter in homogeneous magnetic fields.

(2) I have also observed magnetophotophoresis; it is the movement of particles of the same kind and size in and against the direction of the lines of force in the homogeneous magnetic field[5] when irradiated by concentrated light. They reverse with the field, their velocity being a function of the field strength and light intensity. This phenomenon is the counterpart to electrophotophoresis[6].

(3) I have observed magnetolysis of water, which is proved by the appearance of oxygen (up to 12 per cent per volume) if the two ends of one piece of soft Swedish iron immersed in acidulated water (1–4 per cent acid by volume was used) are magnetized north and south. In the blank experiment without magnetic field, pure hydrogen (0·00 per cent oxygen) is evolved[7]. The quantity of gas evolved depends on the field strength. A so-called permanent magnet of Alnico alloy, fitted with pole-pieces of soft Swedish iron, gave the same result, namely, oxygen was found in the gases evolved and more of the latter was found to be coming from the north pole than from the south. The north pole was attacked more strongly than the south pole and in every experiment a larger volume of gas was collected from the north than from the south pole. Chemical analysis of gas was not made in every case. These phenomena prove again that magnetism is polar[8].

(4) The permanent magnets used lost a portion of their pole strength during the magnetolytic processes as determined by search coil and ballistic galvanometer, and were found to be at a steady state before and after the tests. This is the counterpart of the loss in pole-strength of Volta's pile during electrolysis. The loss of pole-strength per second gives the average intensity of the magnetic current flowing between the pole-faces in absolute magnetostatic units. Using the standardization of the International Electrotechnical Commission, Brussels-Scheveningen*, 1936, the intensity of the magnetic current in practical units can be defined as follows:

Pragilbert × Intensity of Magnetic Current = Watt.

The magnetic currents measured in these practical units have had intensities up to $1{\cdot}7 \times 10^{-10}$.

(5) I have observed an electric vortex (whirl) around the iron wire connecting the two poles of an electromagnet or a so-called permanent magnet in a surrounding liquid bearing electrostatic charges. The same phenomenon occurs if the iron wire is covered by a thin electrically insulating material. This is the counterpart to the magnetic vortex (whirl) around the wire connecting the two poles of Volta's pile (using Oersted's own formulation). Using the dark field of the microscope, I have observed the circulation of a single electric charge, negative or positive, the direction of circulation being opposite in the two cases, this charge being on a bubble in liquid or on a solid particle in liquids or gases in or around the constant vertical homogeneous magnetic field. The intensity of the magnetic current measured electrically is equal to the work done by carrying a unit electric charge once about the entire magnetic current. This electric action of magnetic currents represents the third force in Nature besides the force of gravity and the well-known magnetic action of electric currents (Oersted, Biot-Savart, Lorentz). The use of this third force is *in principio* the magnetic motor[9].

(6) I have also observed that particles can carry simultaneously electric and magnetic charges; this has been concluded from the spiral tracks of bubbles and particles upwards and downwards in the constant vertical homogeneous magnetic field in gases and liquids. Their velocity of motion is of the order of magnitude of 10^{-2} cm./sec. in liquids and 1 cm./sec. in gases[10].

(7) It should be mentioned that there exists a polar movement in the geomagnetic field alone simultaneously with the north and south movements of microscopic particles of nickel or iron in gases at atmospheric pressure, when they are irradiated by light. They cease their movement when the magnetic field of the earth is compensated by an opposing field of the same strength and resume this movement if the compensating field is removed[11].

Furthermore, there is no ground for the doubt, raised by Mr. Kendall, about the validity of measurements of smaller charges than the electronic charge. I discovered and published this first in 1910 and finished this work in 1937, showing that on small

* For these data I am obliged to Brother Gabriel Kane, New York City.

spherical bodies of known density there are electrostatic charges smaller than the electronic charge. Using the same method, I found that the numerical value of the magnetic charge on a single particle, for example, of nickel in gas, can also be smaller than $4–5 \times 10^{-10}$ M.S.U.[12].

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[1] Ehrenhaft, F., *Ann. Phys.*, **13**, 160 (1940).
[2] Ehrenhaft, F., *Phys. Rev.*, **63**, 461 (1943).
[3] Ehrenhaft, F., *J. Frank. Inst.*, **233**, 254 (1942); *Phys. Rev.*, **61**, 733 (1942).
[4] Ehrenhaft, F., and Banet, Leo, *Science*, **96**, 228 (1942).
[5] Ehrenhaft, F., *C.R. (Paris)*, **190**, 263 (1930); *Phys. Z.*, **31**, 478 (1930); *Phil. Mag.*, **11**, 140 (1931); *Ann. Phys.*, **13**, 151 (1940); *J. Frank. Inst.*, **230**, 381 (1940); **233**, 235 (1942); *Nature*, **147**, 25 (1941); *Science*, **94**, 232 (1941). Reeger, E., *Z. Phys.*, **71**, 646 (1931).
[6] Ehrenhaft, F., *Phys. Z.*, **31**. 478 (1930). Placzek, G., *Z. Phys.*, **49**, 601 (1928). Selner, P., *Z. Phys.*, **71**, 658 (1931). Lustig, A., and Soellner, A., *Z. Phys.*, **79**, 823 (1932).
[7] Ehrenhaft, F., *Phys. Rev.*, **63**, 216 and 461 (1943).
[8] Ehrenhaft, F., *Phys. Rev.*, May 1 and 15, 1944.
[9] Ehrenhaft, F., *Phys. Rev.*, **63**, 461 (1943); **64**, 43 (1943); and May 1 and 15, 1944.
[10] Ehrenhaft, F., *Phys. Rev.*, **65**, 62 and 256 (1944).
[11] Ehrenhaft, F., *J. Frank. Inst.*, **233**, 240 (1942).
[12] Ehrenhaft, F., *Phys. Z.*, **11**, 619 (1910), etc.; **39**, 673 (1938); *Nature*, **84**, 182 (1910); see also *Phil. Mag.*, **49**, 633 (1925); *Phil. Sci.*, **8**, No. 3 (July 1941).

Mechanisms for the Relaxation Theory of Viscosity

A RECENT communication by D. D. Eley and D. C. Pepper[1] describes experiments on the plastic flow of plasticized cellulose derivatives. They find that the flow velocity of compression of cylinders and extension of rods depends exponentially on stress at moderate stresses as the simple relaxation theory predicts[2,3], but at higher stresses flow velocity approaches linearity with stress. This behaviour at high stress leads them to question the applicability of the relaxation theory in general to flow problems.

We have observed this same phenomenon in the published data on other disperse systems, such as greases, paints and clay slips. In fact, the phenomenon appears to be characteristic of solid–liquid dispersions the flow of which has in the past been described by the Bingham yield-value equation.

The situation has been explained in the way which we now outline[4]. Consider a system where flow—or place exchange—involves the breaking of at least two types of bonds. Type 1 consists of strong bonds so that they flow according to a non-Newtonian law (at moderate stresses, the exponential law), while Type 2, being weak bonds, obeys the Newtonian law (that is, flow is proportional to stress). The total shear stress, f, is expressible as a sum

$$f = f_1 + f_2, \qquad (1)$$

where f_1 is the shear stress acting on Type 1 bonds and f_2 on Type 2 bonds. Now the rate of shear of each type of bond is given by the hyperbolic-sine law according to the relaxation theory. For the Type 1 (strong) bonds this general law simplifies to the exponential law

$$\frac{ds_1}{dt} = \frac{\lambda}{\lambda_1} k_r e^{f_1 \lambda_2 \lambda_3 \lambda/2kT}, \qquad (2)$$

while for the Type 2 (weak) bonds the general law simplifies to the linear law

$$\frac{ds_2}{dt} = f_2/\eta_2 \qquad (3)$$

Here $\lambda_2\lambda_3$ is the cross-section of the flowing unit on which the shear stress acts; λ_1 is the distance between neighbouring moving units in the direction normal to shear; λ is the distance jumped on each relaxation; k_r is the frequency of the relaxation jump in the direction of flow, at zero stress, and has a well-known form according to the statistical theory of reactions; η_2 is the viscosity due to the Type 2 bonds, which can also be expressed in terms of the dimensions of the unit of flow and the frequency of the relaxation jump for the Type 2 process[2]; k is the Boltzmann constant; T is the absolute temperature.

Now the condition that the two types of bonds shall yield at the same rate is that the shear-rates be equal:

$$\frac{ds_1}{dt} = \frac{ds_2}{dt} = \frac{ds}{dt} \qquad (4)$$

The relation between total stress and shear-rate is thus

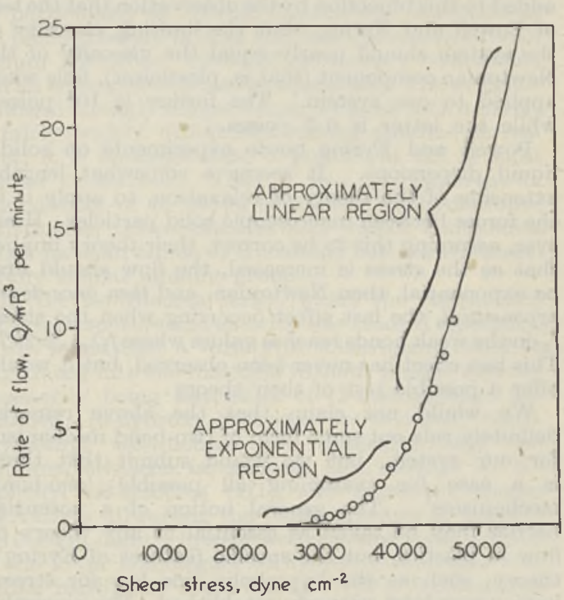
$$f = \eta_2 \frac{ds}{dt} + \frac{kT}{\lambda_2 \lambda_3 \lambda/2} \ln\left(\frac{\lambda_1}{\lambda k_r}\frac{ds}{dt}\right), \qquad (5)$$

which in its simplest form is

$$f = \eta_2 \frac{ds}{dt} + a \log \frac{ds}{dt} + b \qquad (6)$$

In agreement with the results of Eley and Pepper, Eq. (6) gives a shear-rate which depends exponentially on stress at small stresses where the term for breaking of Type 1 bonds predominates, and a shear-rate which depends linearly on the stress at large stresses where the term for breaking of Type 2 bonds predominates. The application of Eq. (6) is illustrated in the accompanying graph, where the equation has been fitted to the data of Blott and Samuel on a lime-base grease[5]. It may be mentioned that the above treatment gives a theoretical explanation not heretofore offered for the curvature always observed at low stresses in 'yield-value' plots.

Two additional tests of the correctness of the present interpretation are available. The first is



THE CIRCLES ARE EXPERIMENTAL DATA FOR A LIME-BASE GREASE STUDIED BY BLOTT AND SAMUEL. THE CONTINUOUS CURVE IS A THEORETICAL CURVE CALCULATED FROM EQUATION 6.

that the slope of the straight-line portion of the curve should correspond to a viscosity which is nearly equal to the viscosity of the Newtonian component of the dispersion. Goodeve and Whitfield have found this to be true for carbon black pastes[6]. The second test is that the temperature coefficient of the flow should indicate an activation energy in the low-stress region typical of the Type 1 bonds, while the activation energy in the high-stress region should have the much lower value typical of the Type 2 bonds. This is confirmed by the reported observations of Eley and Pepper, who find 30 kcal. and 11 kcal. respectively in the two regions.

Thus we conclude not that the relaxation theory of flow treated according to statistical mechanics is in question, but that, given the data on flow of a complex system, one can discover its mechanism.

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[1] Eley and Pepper, *Nature*, 154, 52 (1944).
[2] Eyring, *J. Chem. Phys.*, 4, 283 (1936).
[3] Tobolsky, Powell and Eyring, "Chemistry of Large Molecules", 125 (Interscience, 1943).
[4] Powell, thesis, Princeton University (1943).
[5] Blott and Samuel, *Ind. Eng. Chem.*, 32, 68 (1940).
[6] Goodeve and Whitfield, *Trans. Far. Soc.*, 34, 511 (1937).

Powell and Eyring have shown that the form of the flow/stress relation observed by us may be described by the addition of a second flow-process. Since this second process is postulated to involve weak bonds, it will be Newtonian on their theory.

We would note that the need to assume two types of bond is not so clear for a plasticized polymer as for a solid–liquid dispersion. In fact, Tobolsky and Eyring[1] have considered only one bond, of the strong type, in the flow of plastics, and have derived a theory of extrusion on this basis. Some point may be added to this objection by the observation that the test of Powell and Eyring, that the limiting viscosity of the system should nearly equal the viscosity of the Newtonian component (that is, plasticizer), fails when applied to our system. The former is 10^{8} poises, while the latter is 0·2 poises.

Powell and Eyring quote experiments on solid–liquid dispersions. It seems a somewhat lengthy extension of the theory of relaxation, to apply it to the forces between macroscopic solid particles. However, assuming this to be correct, their theory implies that as the stress is increased, the flow should first be exponential, then Newtonian, and *then once again exponential,* the last effect occurring when the stress f_2 on the weak bonds reaches values where $f_2\lambda_2\lambda_3 \gg 2kT$. This last effect has never been observed, but it would offer a possible test of their theory.

We would not claim that the above remarks definitely rule out some form of two-bond mechanism for our system, but we would submit that there is a case for examining all possible 'one-bond mechanisms'. The general notion of a potential barrier may be taken as essential to any theory of flow in plastics, but the specific features of Eyring's theory, such as the hyperbolic sine law for stress, have never been properly established. For example, a test of this law carried out by Tobolsky and Eyring on creep and stress relaxation in rubber and steel[2] was successful only up to a point, in that the viscous volume parameter, $\lambda_1 \lambda_2 \lambda_3$, was found to depend upon initial stress. The position cannot be clarified until a larger body of evidence is available on the flow of plastics and liquids, including especially Newtonian liquids, over the widest possible ranges of stress and temperature.

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[1] Tobolsky and Eyring, *J. Chem. Phys.*, 11, 131 (1943).
[2] Tobolsky and Eyring, *J. Chem. Phys.*, 11, 128 (1943).

Formation of Apatite from Superphosphate in the Soil

THE bulk of the phosphate added to soils as fertilizer remains in forms unavailable to plants. In calcareous soils it has been said to form hydroxyapatite. From a study of the reversion of mixtures of superphosphate and liming materials, MacIntire and his associates[1] have recently suggested that the ultimate form of some of the phosphate applied to heavily limed soils may be fluorapatite; but, so far as we have been able to ascertain, no direct evidence has ever been obtained of the actual presence in the soil of apatite formed from fertilizers.

The Broadbalk continuous wheat plots at Rothamsted provide favourable conditions for studying this question. Superphosphate has been applied to some of the plots annually for nearly a century, and the whole field had been heavily dressed with local chalk some decades before the experiments commenced. Since it appeared likely that the phosphate would accumulate in or around the soft porous chalk particles, these were isolated from samples of two plots taken in the spring of 1944. Such fragments (0·5–2 mm. diameter) from the plot (No. 5) with superphosphate but no nitrogenous fertilizer contained about 3 per cent P_2O_5, which is ten times as much as on the plot (No. 3) without fertilizer. On heating the chalk from plot 5 to 800° and extracting with carbon dioxide-free sucrose solution to remove calcium oxide, a residue was left which gave the X-ray powder diagram of apatite. A partial analysis of a 140 mgm. sample of the residue gave 47 per cent CaO, 26 per cent P_2O_5, 1·5 per cent F and 10 per cent insoluble in hydrochloric acid. (Some fluorine was lost during the ignition.) The refractive index was n_D 1·601. Efforts to isolate the phosphate from the chalk without heating have not yet been successful, but X-ray diffraction data suggest that apatite is present.

Further analyses showed that where superphosphate had been applied, the phosphate content increased rapidly with decreasing grain size of the chalk fragments. The values for individual grains were highly variable, but consistent results were obtained by separating the whole of a given fraction from a bulk soil sample.

P_2O_5 PERCENTAGE OF CHALK FRAGMENTS FROM BROADBALK SURFACE SOIL (SECTION 4), 1944.

	Plot 5	Plot 3
Mean values in whole fraction from 500 gm. soil		
0·5–2 mm.	2·8	0·33
2–5 mm.	2·0	—
Individual grains 3–7 mm.		
Mean	1·4	0·13
Extremes	0·09–5·5	0·045–0·23

Analyses of chalk fragments from Plot 5 (0·5–2 mm. diameter, isolated from 100 gm. soil sampled in 1865 and from 500 gm. from later samples) showed that the phosphate and fluorine contents increased gradually with time, and at an increased rate from about 1888 onwards. From 1852 until 1888 the superphosphate had been made from bone ash, which contains little fluorine; afterwards mineral phosphate was used and considerable amounts of fluorine would therefore be added annually.

P_2O_5 AND F PERCENTAGES IN CHALK FRAGMENTS FROM BROADBALK SURFACE SOILS.

		% P_2O_5	% F
Plot 5			
	1865	0·28	n.d.
	1881	0·44	0·032
	1893	0·80	0·045
	1901	1·15	0·078
	1914	1·7	0·11
	1944 (section 4)	2·8	0.25
Plot 3			
	1881	0·13	0·032
	1944 (section 4)	0·33	n.d.

Throughout the experiment the plots have steadily lost calcium carbonate by leaching[2]. This may account in part for the increase in P_2O_5 percentage in the chalk fraction of the unmanured plot, but it can only be a secondary factor in the accumulation of phosphate in the chalk from Plot 5.

Further work is in progress on the formation of apatite in soils and its relation to phosphate fixation.

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[1] MacIntire, W. H., and Hatcher, B. W., *Soil Science*, 53, 43 (1942).
[2] Hall, A. D., and Miller, N. H. J., *Proc. Roy. Soc.*, B, 77, 1 (1905).

Heredity, Development and Infection

DR. DARLINGTON'S[1] interesting article on "Heredity, Development and Infection" calls for two comments. He states that the "molecular system" of heredity, consisting of plasmagenes, "has been hitherto supposed to be purely maternal in inheritance". There is at least one case to the contrary in animal genetics. L'Héritier and Teissier[2] found that the character of susceptibility to carbon dioxide in *Drosophila melanogaster* was transmitted to all the progeny of a susceptible mother, but to a fraction only of those of a susceptible father. Kalmus[3] found that the same was true in an interspecific cross.

Dr. Darlington later cites Crane and Lawrence's[4] conclusion that roses may revert from the climber to the bush type as the result of bud-grafting on to a dwarf stock. He regards the agent transmitted as a plasmagene rather than a virus, since the bushy habit of growth in roses cannot be considered pathological. He later adds that "The high frequency of plasmagene and virus mutations, aggravated by the rapidity of their selection, both under nuclear control, gives an almost Lamarckian colour to their adaptation".

Lysenko and his colleagues in the U.S.S.R. have reported a large number of cases in which characters have been transmitted from one plant variety to another by grafting. They have been accused of Lamarckism, among other things. It would seem that British plant geneticists are now discovering similar phenomena. It may be that Lysenko, with the enthusiasm of a pioneer, has criticized Mendelian conceptions unjustifiably, as the biometric school did in Great Britain. But this is scarcely a sufficient reason for ignoring his work, particularly as some of his publications antedate that cited by Dr. Darlington. I yield to no one in my admiration of the work of the American drosophilists on nuclear genetics, which I supported in Great Britain when the chromosomal theory of inheritance was unfashionable. But perhaps we can also learn from our other allies.

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[1] *Nature*, 154, 164 (1944).
[2] *C.R. Acad. Sci. Paris*, 205, 1099 (1937); 206, 1193, 1683 (1938).
[3] *Nature*, 152, 692 (1943).
[4] "Genetics of Garden Plants", 2nd ed. (London, 1937).

Pressor Effects of Amidine Derivatives

MANY compounds of general formula *R.X.*C(: NH)NH_2—where *R* is an alkyl group attached to the amidine portion of the molecule either directly ('amidines') or through a divalent radical, *X*, which may be an oxygen atom (*iso*-ureas), a sulphur atom (*iso*-thioureas) or an imino-group (guanidines)—have in common a number of distinctive pharmacological properties[1–4]. Thus representative members of each series have been shown to raise the blood pressure of anæsthetized animals and to enhance the pressor effect of adrenaline by mechanisms which are either partly or wholly peripheral. The increase in tonus produced in different smooth muscle preparations is probably the result of a direct action on the muscle itself[2,3,4].

These investigations have since been extended. Preliminary tests were carried out with some two hundred compounds, the following effects, which were recorded as in previous studies, being looked for particularly as criteria of activity: elevation of the blood pressure in dogs and cats anæsthetized with sodium barbitone, increased pulmonary ventilation and an enhanced response to adrenaline. The evidence obtained strongly suggests that, whereas such activity is fairly widely distributed among amidine derivatives, it is inconspicuous, if present at all, in most related substances. Thus it was not apparent in imino-ethers or in ureas, thioureas, thiohydantoins, carbamates, thiocarbamates and similar compounds which have an amide or thioamide but not the structurally similar amidine group.

In the *iso*-thiourea series, where the relationship between structure and activity was studied especially, it was found that a variety of substituents could be introduced into the molecule without pressor activity necessarily being lost, salts of (2-methyl-)allyl *iso*-thiourea, (3-hydroxy-)*n*-propyl *iso*-thiourea, methoxymethyl *iso*-thiourea (I), (2-phenyl-)ethyl *iso*-thiourea, ethylene *iso*-thiourea (II), methyl N, N'-diphenyl *iso*-thiourea (III), and numerous similar derivatives all raising the blood pressure in doses of 1–10 mgm./kgm. Pressor activity was most evident in the lower homologues of methyl *iso*-thiourea but, unlike methylene di-*iso*-thiourea (IV), formamidine disulphide (V) had little effect on the blood pressure. A few related compounds (for example, hexamethylene

(I) $CH_3.O.CH_2.S.C(:NH)NH_2$

(II) $H_2C.S.C:NH$
  | |
H_2C — NH

(III) $CH_3.S.C(:NC_6H_5)NHC_6H_5$

(IV) $H_2N(HN:)C.S.CH_2.S.C(:NH)NH_2$

(V) $H_2N(HN:)C.S—S.C(:NH)NH_2$

(VI) $H_2C.S.C:NH$
  | |
O : C — NH

di-*iso*-thiourea) produced sustained falls. Derivatives with substituents in the amidine part of the molecule (for example, II and III) may cause well-defined pressor effects but, as a rule, activity is reduced or even abolished by this procedure. More examples of *iso*-thioureas displaying little activity were found in compounds like the hydrochlorides of acetyl and carbomethoxy *iso*-thioureas (which do not keep well *in vitro*) and *iso*-thiohydantoin (VI). Fewer amidine derivatives belonging to other series (guanidines, amidines, *iso*-ureas) were examined, but the results obtained indicate that the pressor activity of lower members is influenced by structural changes in much the same way as that of the corresponding *iso*-thioureas.

Many of the compounds altered the sensitivity of the preparation to the pressor action of adrenaline. The response to the latter was increased especially, but by no means invariably, by those pressor amidines which showed tachyphylaxis to a considerable extent. A decrease in sensitivity was also noticed sometimes, compounds such as carbomethoxy and benzyl *iso*-thiourea hydrochlorides often having adrenalytic effects in cats. These two salts, unlike most others, normally increased the pulse-rate.

Although the fifty-odd amidine derivatives which were shown to be pressor differ to a remarkable extent from the point of view of chemical constitution, they resemble one another more closely in the possession of certain physical properties. Measurements of the ionization constants of the parent bases show that the majority at least are strong electrolytes. The values obtained or found recorded for such *iso*-ureas and *iso*-thioureas ($pK_a \simeq 9$–11) are less than those for the corresponding amidines ($pK_a \simeq 12$) and guanidines ($pK_a \simeq 12$–14), but are still sufficiently high[5] to allow for 99–100 per cent ionization in water, if not in blood, at pH 7·3. No examples have been found as yet of weak amidine bases the salts of which are strongly pressor. On the other hand, some of the amidine derivatives which have little effect on the blood pressure were shown to be extensively hydrolysed in solution ($pK_a \simeq 7$ or less) and so should provide a smaller concentration of amidine cations than their more active relatives under the same conditions. Other strong organic bases (for example, ethylamine, tetramethylammonium, acetylcholine) may differ widely in their circulatory effects from typical amidine derivatives; possibly the basicity is of importance in so far as it determines access to the effectors[6]. In this connexion it is of interest that the pressor activity of amidine derivatives (but not apparently some of their other properties[7,8,9]) seems to be affected adversely by an increase in the length of sidechains even though the basic ionization constant may be unaltered or actually increased at the same time. The possibility that amidine cations alter the properties of cells through successful competition with inorganic cations of physiological importance has not been overlooked.

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July 14.

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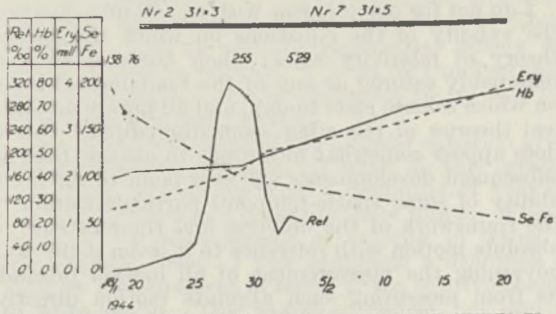
Nature of the Anti-anæmic Factor (Castle)

IN a series of papers I have advanced the theory that the intrinsic factor of Castle might be identical with the enzyme aminopolypeptidase[1,2,3]. In brief, the experiments reported in these papers demonstrated that intravenous injections of crystalline secretin provoked in cats a secretion from the mucous membrane of the distal part of the pyloric and the proximal part of the duodenal region, the part of the alimentary canal from which the intrinsic factor is considered to be secreted[4,5]. The secretion contained a rather high concentration of aminopolypeptidase. In accordance with the results obtained by Castle, it was demonstrated that an enzymatic reaction (proteolysis) took place after incubating the secretion with a muscle extract. When preparing the enzyme from the hogs' pyloric mucosa, it was found that purified enzyme solutions apparently contained most of the intrinsic factor activity present in the mucous membrane. The intrinsic factor activity was estimated by allowing the purified enzyme solution to react with liver according to the methods outlined by Reimann[6] and Sjögren[7]. At this stage of the investigation (1941) the aminopolypeptidase had been purified about ten times. Since then, the enzyme has been further purified, in all about a hundred times.

The intrinsic factor activity of this purified enzyme has now been tested. The method of purifying will be published elsewhere. The estimation of the intrinsic factor activity of the purified aminopolypeptidase solution was based on the following experimental results. The concentration of aminopolypeptidase in the fresh pyloric mucosa was determined. Then it was easy to calculate the amount of enzyme activity present in the sample of pyloric mucosa used by Sjögren as intrinsic factor material. The next step was the determination of the aminopolypeptidase activity of vacuum-dried pyloric mucosa. This was the material from which the enzyme of the present investigation was prepared. It was found that half the original aminopolypeptidase activity was left after the desiccating process. As 1 gm. of the dried material corresponded to 6 gm. of fresh material, it was easy to calculate how much of the purified enzyme would be used in the activating experiment.

In the course of this, the aminopolypeptidase from 10 kgm. of vacuum-dried pyloric mucosa was purified a hundred times. As the yield by the method of preparation used was 25 per cent, the amount of aminopolypeptidase activity in the solution of the one hundred times purified enzyme was the same as in



GRAPH SHOWING RESPONSE IN A CASE OF PERNICIOUS ANÆMIA TO ORAL TREATMENT WITH LIVER PREPARATION NOS. 2 AND 1 ACTIVATED WITH ONE HUNDRED TIMES PURIFIED AMINOPOLYPEPTIDASE.

7·5 kgm. of fresh pyloric mucosa. The solution was halved (dry weight of each was 10·5 gm.). One half of the solution was substituted for the intrinsic factor activity of 3·7 kgm. of fresh pyloric mucosa in the activation of raw liver. This preparation was called No. 2. In preparation No. 1 the other half of the enzyme solution was substituted for the intrinsic factor activity of 7·5 kgm. of fresh pyloric mucosa. It was assumed that if the intrinsic factor activity had really been purified parallel with the aminopolypeptidase activity, then it should be possible to trace the activating effect of half the optimal dose of intrinsic factor on liver. The daily therapeutic dose of preparations 1 and 2 contained material from about 30 gm. of fresh activated liver, and were given orally to the patients in the form of 3 × 5 tablets. The preparations were tested with positive results on four patients with pernicious anæmia. The results of the treatment are demonstrated in the accompanying graph, which shows that both preparations, Nos. 1 and 2, are active. The clinical results, therefore, seem to favour the assumption that aminopolypeptidase may be identical with the instrinsic factor. A detailed report will be published elsewhere[8].

GUNNAR ÅGREN.

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June 20.

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[8] Ågren, G., and Waldenström, J., *Acta Med. Scand.* (in the Press).

Variation of Ascorbic Acid in Tomatoes

IN view of the wide differences of ascorbic acid content within various types of fruit and vegetables reported in the literature, we have recently carried out a study of some of the sources of variation in the tomato.

Our figures suggest that the sample size should be at least sixteen separate fruit taken at random from the batch or plot for any intervarietal differences to be significant, and this would indicate that many of the results quoted in the literature show divergences for this reason.

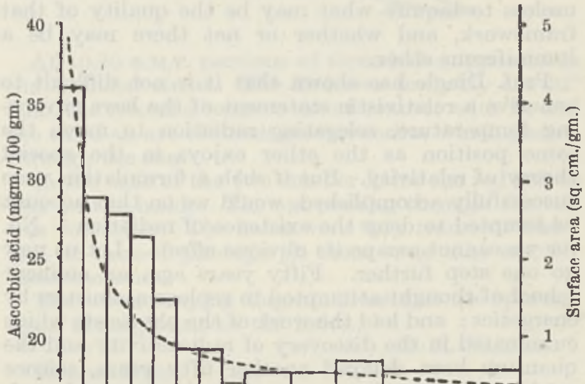
The fruits of any one variety may show wide variations, however.

We find that the ascorbic acid content of the fruits of one bush, although showing considerable constancy in all the fruit ripe at any one time, tends to increase as the plant ages. This was found to hold whether the fruits were collected from plants grown either during the spring when the days were lengthening, or during the autumn, when they were shortening.

We have also found a very marked bush-to-bush variation. The difference between the highest and lowest ascorbic acid contents found in the fruits of any one variety grown in one plot were of the order of 100 per cent (24–51 mgm./100 gm.). This is considerably greater than the variation between the mean ascorbic contents of the different varieties grown. By growing plants from the seed taken from tested tomato plants, we found that this plant-to-plant variation tends to persist in the crop of the following year. Selection in this manner seems to offer some prospect of building strains of any variety which would be high in ascorbic acid content and yet still possess desirable market qualities.

Most striking of all, however, has been the finding that the ascorbic acid content is closely related to the size of the fruit within certain size limits, as can be seen from the graph. The histogram of weight against ascorbic acid suggested that the tomatoes might be divided into two groups, separated at 30 gm. weight. Analysis of these figures showed that the fruit of less than 30 gm. weight gave a correlation coefficient of $-0·94$, highly significant at the 1 per cent level for the effect of weight on ascorbic acid. Those fruit of 30 gm. and more, on the other hand, gave a non-significant coefficient of $-0·03$.

All the fruit came from six bushes of one variety from which every fruit was collected and analysed. On the admittedly crude assumption that the fruit was spherical, the relationship between weight and surface area was worked out, and is represented by the accompanying curve. The close similarity between this curve and the histogram is obvious. As the weight increases there is a rapid decline in the surface area/weight ratio in the small fruit; but as the fruit becomes heavier, the decrease becomes less and less marked. If we make the assumption that the ascorbic acid is to a large extent synthesized in the fruit, by the effects of light rays, then the content of ascorbic acid present would vary with the amount of light energy received per unit weight of fruit. On this hypothesis, the wide surface area/weight ratio of the smaller tomatoes would be responsible for their higher ascorbic acid content, since for these the



ratio of light energy received to the weight of the fruit would be greatest.

The universality of this relationship even in tomatoes remains yet to be worked out, but these results at least cast some doubt on the value of the suggested use of *Lycopersicon pimpinellifolium*, which bears very small fruits, in a tomato breeding programme designed to produce fruits of a high ascorbic acid content[1].

Examination of other data available in the literature in the terms of this hypothesis may be fruitful. For example, a varying surface area/weight relationship may be partly responsible for the variation in ascorbic acid content of different species of Rosa previously attributed to genetical influences[2]. The increase in the ascorbic acid content in the tetraploid as compared with the diploid cabbage reported by Barr and Newcomer[3] is accompanied by a decline in weight. The same factors may be operating here.

The results will be published in detail elsewhere.

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V. M. LEWIS.

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[1] Lyon, C. B., Beeson, K. C., and Ellis, G. H., *Bot. Gaz.*, 104, 495 (1943).
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The Laws of Nature

PROF. H. DINGLE's very interesting article[1] has laid bare in the clearest and most unambiguous terms the dubious validity, not so much of the distinction which the formulæ incidental to the historical development of science have imposed on our fundamental conceptions, resulting in an apparent deep-rooted contradiction between the equations representing the reaction of matter towards motion and temperature, but of an extension of the special theory of relativity which at present appears to pass without comment or challenge. It is usual to assume—and Einstein has himself lent authority to the assumption—that because the relativistic form of the equations of motion (apparently) for ever bar any measurement of absolute velocity relative to the framework of the universe, therefore absolute velocity with respect to any such framework does not exist; and, as a further extension, that it is trivial and useless to inquire what may be the quality of that framework, and whether or not there may be a luminiferous ether.

Prof. Dingle has shown that it is not difficult to conceive a relativistic statement of the laws governing temperature, relegating radiation to much the same position as the ether enjoys in the special theory of relativity. But if such a formulation were successfully accomplished, would we on that account be tempted to deny the existence of radiation ? No, for we cannot escape its obvious effects. Let us now go one step further. Fifty years ago, an eminent school of thought attempted to replace atomistics by energetics; and had the work of the physicists which culminated in the discovery of radioactivity and the quantum been delayed another fifty years, science might well to-day have promulgated a dogma according to which it was trivial and useless to inquire whether atoms did or did not exist, and averring that their existence was after all improbable.

I do not for one moment wish to call into question the validity of the equations on which the special theory of relativity rests; their basis appears as reasonably assured as any of the fundamental bases on which science rests to-day, and all purely mechanical theories of the ether seem discredited. But it does appear somewhat incautious to assume that no subsequent developments will ever point to the probability of some spatio-temporal particularization of the framework of the universe and the existence of absolute motion with reference to it, even if the laws governing the measurement of all motion preclude us from measuring such absolute motion directly, leaving us only the possibility of inferring its existence from some otherwise inexplicable phenomenon. Lorentz's contracting electron is only one of a series of mechanisms whereby the impossibility of the measurement of absolute motion can be explained; and it appears invidious to argue about the philosophical probability or improbability of what is, after all, as yet only incompletely understood.

Incidentally, Prof. Dingle states that "a measurement of velocity in terms of the Doppler effect would have given us a finite limit in one direction and an infinite one in the other". This statement, while in no way invalidating the fundamental concepts on which the article is based (measurement in terms of the Doppler effect is primarily cited as a striking example of a measure of velocity invariant with respect to time), seems somewhat strange in an article of which the essence is a plea for "thermal relativity", inasmuch as the relativistic form of the Doppler equation gives an infinite limit for both approach and recession.

A. C. JESSUP.

"Chomlea", Claremont Road,
Pendleton, Salford, 6.

[1] *Nature*, 153, 736, 758 (1944).

MR. JESSUP's letter raises what, I think, is a fundamental point concerning the significance of relativity theory. In adopting that theory, we do not assume that "no subsequent developments will ever point to the probability of some spatio-temporal particularization of the framework of the universe". We simply regard scientific theory as a description of the world apprehended by experience (more exactly, the correlation of experiences themselves), and require that it shall not include features for which experience offers no evidence. For that reason, we regard a theory which includes the existence of absolute velocity as invalid. If future experience should enable us to detect absolute velocity, or even "leave us only the possibility of inferring its existence from some otherwise inexplicable phenomenon", the situation would be altered, and the same principle would then require us to include it in our description. In brief, scientific theory should be, so far as possible, conterminous with experience.

Mr. Jessup's statement that we cannot deny the existence of radiation because we cannot escape its obvious effects is somewhat ambiguous. We cannot escape certain phenomena, but the point is whether they are to be described as effects of radiation. If by radiation we mean something issuing from a body at temperature θ, and proportional in magnitude to θ^4 irrespective of the temperature of the surroundings (as is implied in the generally adopted theory of exchanges), then the above-mentioned principle requires us to deny it. All that we have been able to observe are effects depending on $a(\theta^4-\theta_0^4)$, where

θ_0 is the temperature of the surroundings, and a is a constant. The "obvious effects" are effects of *relative* radiation, just as obvious mechanical effects are effects of relative velocity. θ^4 is (so far) unobservable *absolute* radiation, and is analogous to (so far) unobservable absolute velocity.

The relativistic form of the Doppler equation gives limiting velocities of $\pm c$. It must do this because it is made to conform with a definition of velocity (namely, ds/dt) which demands those limits. When I spoke of "a measurement of velocity in terms of the Doppler effect" I was imagining a *definition* of velocity measurement in terms of the relative change of wave-length. This would, of course, not lead to the ordinary relativistic equation, but to $d\lambda/\lambda = v/c$, where c is a constant. Such a definition would, fundamentally, be as legitimate as the canonical one, and would enable us to describe the same phenomena, but the description would, of course, be different.

HERBERT DINGLE.
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Aug. 23.

A Solar Halo Phenomenon

A PHENOMENON which I have not seen described before occurred in a part of the horizontal ring of a solar halo on August 9, 1944. It consisted of dark bands moving like waves through the very bright ring. The sky was very clear at Cambridge on the morning of that day when a cloud trail was formed by an aeroplane. The trail moved from north-west in an easterly direction. At 11.20 a.m. a section of the horizontal mock sun ring appeared in that part of the cloud which in the north-east had the same altitude as the sun. As the cloud moved on, being steadily deformed and taking the shape of the letter *S*, the halo shifted slowly from left to right.

About a minute later, I noticed dark bands crossing quickly through the brightness of the halo. They were of various grades of darkness and could not be seen continuously. Each band was about $\frac{1}{5}°$ in width and seemed to be perfectly straight. The distance between two adjacent bands was approximately $\frac{1}{2}$–1°. The middle one of a batch of bands was usually the darkest, the brightness of the brilliant mock sun ring being reduced by more than 75 per cent, while the accompanying bands were less dark. The best description of the phenomenon I can give is by comparing it with the rippling of the smooth surface of a lake by an occasional breeze. The bands moved from right to left and their speed seemed very high, approximately 5° per second, that is, very much faster than that of any cloud seen in the sky on that day. They gave the impression of being lower than the halo.

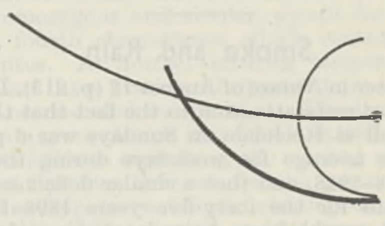
I called a second observer who independently noticed the phenomenon after I had directed his attention to the spot. A description was given in the words: "It is as if the ether waves have become visible".

At 11.25 a brilliant mock sun appeared on the right of the sun. The 22° halo developed and at 11.30 a mock sun could be seen on the left. However, no dark bands were visible in them. Later, a part of the horizontal ring appeared in another cloud trail at 11.45 a.m. The bright patch was this time in the north-west. First one dark band moved quickly through the patch in a northerly direction, taking about $\frac{1}{2}$ sec. to cross it. A few seconds later a whole batch of waves followed, going in a slightly different direction. Then lower clouds covered this part of the sky.

In attempting an explanation of the phenomenon three points will have to be kept in mind. First, the mock sun ring is a halo of the reflexion type produced by ice crystals the side faces of which are orientated in vertical planes and act as mirrors. A slight variation in the direction of the axes of the crystals has a marked effect on the appearance of the halo. I have seen fluctuations of brightness in another reflexion type halo before, namely, in the pillar above and below the sun, but the phenomenon described above is quite different. Secondly, the artificial cloud was less thick than a natural one. A high percentage of the ice crystals situated in the line of sight could therefore be affected simultaneously. Thirdly, different wind directions at various heights at the time of observation were revealed by clouds. Directions noted were north-west, north-east and south-west at ground-level. The deformation of the originally straight aeroplane trail to an *S*-shaped figure proves that the cloud was at a height where two different air currents came into contact. A disturbance may have been caused at the surface of contact, thereby affecting the orientation of the axes of the ice crystals. The swinging of the crystals about their position of equilibrium may have produced the observed optical effect.

G. H. ARCHENHOLD.
c/o Solar Physics Observatory,
Cambridge.

ON August 9, at 0900 G.M.T., numerous aeroplane vapour trails had spread out into wide belts of apparently cirrus cloud. Two mock suns were then visible, one at about 22° from the sun and one nearly opposite to it and at about the same height above the horizon as the sun. These mock suns disappeared after a few minutes.



At 10.30 G.M.T. portions of three halos appeared in the artificial cirrus. The first was probably the 22° halo, the second a concave arc of contact with it, and the third an arc of much greater radius which passed through the sun.

In the case of the two smaller halos the red colour was on the inside. The arc passing through the sun was colourless. The halos were very transient and I had no time to photograph them or to take angular measurements.

The accompanying diagram illustrates the approximate arrangement of the halos.

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Kennel Moor,
Milford,
Godalming,
Surrey.

THE communication from Mr. C. J. P. Cave[1] prompts me to record a somewhat similar experience. At 7.30 p.m. G.M.T. on the evening of August 3, the sky was clear except for a patch of striated cirrus cloud high up in the sky in a north-westerly direction. There suddenly appeared a band of colours right across this patch as if it were a rainbow. As the sun sank towards the horizon the band of colour moved downwards across the cloud, with an increase in the intensity of the colours. At one time part of a 'secondary' band of colour was visible, but this quickly faded as the band approached the lower edge of the cloud patch. The whole phenomenon lasted approximately fifteen minutes or so.

ERIC H. DOCK.
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Sept. 8.

[1] *Nature*, 154, 240 (1944).

Spectrum Formed on a Cloud

BETWEEN 8.55 and 9.00 p.m. British Summer Time on the evening of July 31, my family and I happened to be in our garden looking *towards* the setting sun. The sky was blue, broken by a few wisps of feathery cloud. When two wisps passed in turn at an elevation of roughly 60–70° between us and the sun, each showed a brilliant spectrum. The colours violet, blue, green, yellow, orange and red were clearly seen, violet being on top and red below.

The colours were much more brilliant than in any rainbow we have ever seen; they were evidently projected upon the clouds and the spectrum was therefore real and not virtual. There was no sign of rain at the time and the sun was a bright red ball, hidden from us by trees.

A spectrum such as above described may not be uncommon, but none of us has observed one before.

E. NIGHTINGALE.
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St. Albans.

Smoke and Rain

IN a letter in *Nature* of August 12 (p. 213), Dr. J. R. Ashworth directs attention to the fact that the average rainfall at Rochdale on Sundays was 6 per cent below the average for weekdays during the thirty years 1898–1928, and that a similar deficit is evident if the data for the forty-five years 1898–1943 are used. It would have been interesting if he had quoted separately the figures for the latest fifteen years, 1929–43.

The average annual rainfall for each day of the week during 1929–43 can be deduced from the figures quoted in Dr. Ashworth's letter, and appear to be as follows:

Sun.	Mon.	Tues.	Wed.	Thurs.	Fri.	Sat.
5·69	5·56	5·54	6·37	5·90	6·21	6·42 in.

The rather large variations between different days suggest that a period of fifteen years is too short to eliminate the effect of random fluctuations in the rainfall. Nevertheless, the fact that Sunday is only the third driest day suggests that the factors which previously caused Sunday to have the lowest rainfall have now ceased to operate.

Assuming that rainfall is increased by smoke in the atmosphere, the explanation is probably as follows: First, as Dr. Ashworth suggests, the increasing use of electric power has decreased the output of smoke from factories. Secondly, this has probably been accompanied by an increased number of private houses heated by coal fires, which are lit on Sundays as well as weekdays. It therefore seems likely that smoke from domestic coal fires is now a major factor in polluting the atmosphere of urban areas.

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Carnforth, Lancs.

Books: The Warehouse of Knowledge

I HAVE read with interest and appreciation your leading article "Books: The Warehouse of Knowledge" in *Nature* of September 9, 1944. That article is supported by "A Reading Survey" issued by the City of Leeds Public Libraries, and a corresponding survey in technical or scientific libraries might provide even more emphatic support. There are, however, two further points which I think should be borne in mind.

(1) Not only are books of importance for general education and technical training, but also the provision of adequate text-books and monographs on special subjects is of vital importance in research.

(2) Very few technical and scientific books of this class are now being published in Great Britain. The reasons for this are fairly clear from this leading article. The seriousness of this situation is not, however, sufficiently realized. Before the War any shortcomings in the British supply of books could be rectified by the supply of German and other European books as well as American books. The supply of such books has now been reduced to almost negligible proportions under the Trading with the Enemy Regulations, and it now appears that increasing difficulties are being experienced, owing to Government regulations, in obtaining from America the supplies of scientific and technical books which our research workers require for day-to-day purposes. The Government policy with regard to paper control is only part and parcel of a policy and attitude to technical and scientific books which tends to frustrate the effect of proposals for the expansion and development of research.

R. BRIGHTMAN.
Hexagon House, Blackley,
Manchester. Sept. 13.

Importance of Film Records

REFERRING to Dr. M. Michaelis' communication in *Nature* of September 16, p. 365, I am, of course, well aware of the activities of the newly formed Scientific Film Association. Like the British Film Institute, however, it can only make contact with central organizations. These may or may not know what films are in existence on their particular subject.

Most scientific workers read *Nature*. It is to the individual maker of films that I appeal, in the hope that the learned societies may thus be persuaded to take action. Spreading the burden is preferable to allowing it to fall on the shoulders of any one organization, whose judgment as to what is and what is not worthy of preservation cannot be so authoritative as that of workers in the same field.

OLIVER BELL.

RESEARCH ITEMS

Columbia River Salmon

THE *Stanford Ichthyological Bulletin* (2, No. 6 ; Dec. 1943), published by the Natural History Museum of Stanford University, contains a paper by John C. Marr on "Age, Length, and Weight Studies of Three Species of Columbia River Salmon (*Onchorhynchus keta, O. gorbuscha* and *O. kisutch*)", being Contrib. No. 9, Department of Research, Fish Commission of Oregon. The salmon runs of the Columbia River have held an important place in the economic structure of Oregon and Washington since the beginning of their exploitation in the 1860's. The fishing intensity has increased constantly and the reduction of spawning areas, brought about by the construction of dams and other developments of water resources, have acted unfavourably to modify natural conditions and the productivity of the fisheries. In the genus Onchorhynchus the most important commercially is the chinook salmon *O. tschawytscha* ; the next in importance are the steelhead *Salmo gairdneri*, the blueback *Onchorhynchus nerka*, the silver salmon *O. kisutch* and the chum *O. keta*, while the pink salmon *O. garbuscha* is not sufficiently numerous to be of commercial importance. As the runs of the chinook and blueback which ascend to the higher reaches of the river system are seriously depleted, the trend of the catch of silvers and chums has been upward in recent years due to an increased fishing intensity. Since they spawn in the lower tributaries they have suffered relatively less from the destruction of spawning beds. Thus they will probably become increasingly important in the commercial fishery, and their life-histories are now being thoroughly investigated. The present work deals in detail mainly with the age, length and weight of *Onchorhynchus keta* and *O. kisutch*. It is demonstrated that, in comparison with data from other localities, in both from south to north there is a decrease in mean length at the same age ; older fish are progressively more abundant and the runs are progressively earlier.

An Interesting Larval Trematode

R. M. Cable and Richard A. McLean record the occurrence of *Cercaria clausi* Monticelli, a marine larval trematode, on the west coast of Florida (*Notulæ Naturæ*, Academy of Natural Sciences of Philadelphia, No. 129; 1943). This is a rare type of cercaria which has the peculiar habit of forming rosettes, the tails clinging together and the bodies sticking out from the centre of the mass. The present specimens were found inhabiting the marine prosobranch gastropod *Lamellaria leucosphæra*, which in captivity gave out the cercariæ. There is an interesting point, namely, that the host of this worm is recorded as both *Lamellaria leucosphæra* and *Trivia europea*. Recent classification places *Lamellaria* and *Trivia* very close together and both possess pelagic larvæ of the echinospira type. It may very well be that the miracidium enters the host when in this pelagic echinospira phase. A search for such larvæ might be fruitful and of interest. If this supposition were proved, it would indicate a final host which was pelagic and not of necessity living always in the near neighbourhood of the mollusc. Photographs are given of the larvæ in this paper, but clear drawings are much needed also.

Sporulation in Yeast

C. C. Lindegren and E. Hamilton (*Bot. Gaz.*, **105**, 316 ; 1944) and C. C. Lindegren and G. Lindegren (*Bot. Gaz.*, **105**, 305 ; 1944) have discussed the process of spore formation in yeast. After describing a new medium which gives the maximum spore formation of cultures, they show that the genetic constitution has a considerable influence upon spore formation. Legitimately diploid strains sporulate regularly and well, whereas single-spore cultures which may be either haploid or illegitimately diploid are irregular and sparse. The analysis of forty baker's yeasts showed that some were diploid while others were of single spore origin. Sporulation occurs more readily at the edge of the colonies where many of the cells are autolysed. These cells may supply necessary nutrients for the sporulation. It was known from the work of Nickerson and Thieman that riboflavin and sodium glutarate were specific substances for conjugation and sporulation. The parallelism with the paraphyses in Pyrenomycetes and with the structure of bacterial colonies is pointed out. From the cytological investigations of Lindegren and of Badian it would appear that chromosomes exist in bacteria and that they undergo similar changes to those observed in higher plants. There are two chromosomes in the diplophase of yeast. In a further paper by C. C. Lindegren and G. Lindegren (*Proc. U.S. Nat. Acad. Sci.*, **29**, 306 ; 1944) it is shown that the four spores of one ascus of certain strains of *Saccharomyces cerevisece*, which persistently produce haploid cultures from single spores, are of two types. Pairing and sporulation occur regularly and easily between but not within these two types. It is believed that allelomorphs controlling incompatibility are present as in fungi. The authors confirm the fact that *Torula* forms are imperfect forms of *Saccharomyces* and when properly mated produce copulation tubes of the pattern of *Zygosaccharomyces*.

Iso-allelomorphism

C. Stern and E. W. Schaeffer (*Proc. U.S. Nat. Acad. Sci.*, **29**, 361 ; 1944) provide evidence for an important aspect in evolution. Three strains of *D. melanogaster* were homozygous and similar, except for the genes on the fourth chromosome which contains cubitus interruptus. At normal culturing temperatures 25–26°, these three strains all appeared to contain the similar normal allelomorph of *ci*. When raised at 14° one strain gives *ci* type individuals as well as normal. When this locus containing the normal allelomorph is present in flies deficient for the partner chromosome (hemizygotes) a different strain produces *ci* type individuals. When tested as heterozygotes with *ci* and especially with *ciw*, the normal allelomorphs of *ci* in the three strains are further separated. These *iso*-alleles have been found in many loci in Drosophila and in other organisms previously. The importance of the *ci* case is that the wild types in the three strains tested were found to be different. The prevalence of these small genic differences which have no immediate striking or switch effect is of great importance in evolution.

Pathogenicity of *Ophiobolus graminis*

THE complex pathogenicity of the fungus *Ophiobolus graminis* on cereals is discussed in a brief paper by N. H. White and G. A. McIntyre (*J. Coun. Sci. and Ind. Res. Australia*, **16**, 2 ; May 1943). Eight single-spore isolates of the organism, derived from eight ascospores within a single ascus, were grown upon three different media and inoculated on two kinds of sandy loam soil. All three of these factors affected the pathogenicity. One strain produced no disease; another infected 89 per cent of the plants. Relative differences between isolates were not the same for different media, though straw medium was generally most suitable and soil medium least so. Differences in pathogenicity due to variation in cropping soil were usually small, but changed with the isolates. Any control of this fungus must therefore overcome the extreme variability of the pathogen.

Composite Nature of Spotted Wilt Virus

D. O. NORRIS announces in a short note (*J. Coun. Sci. and Ind. Res. Australia*, **16**, 2; May 1943) that the spotted wilt virus of tomatoes is a mixture of at least three strains. The virus was obtained from potatoes at Canberra, and the three components form necrotic, ringspot and mild symptoms respectively. The necrotic strain appears to be identical with tomato tip blight described by Milbrath (1939) in Oregon. This discovery should explain the many observed variations in the severity of spotted wilt, for the symptoms will thus vary according to the number and ratio of strains which are present.

The Sprengnether Vertical Seismograph

WILLIAM SPRENGNETHER, JUN., of St. Louis, has designed an instrument to meet the demand for a simple, low-priced, short-period vertical-component seismograph of fairly high sensitivity (*Trans. Amer. Geophys. Union*, 1941). The frame consists of a rigid truss with a long hinge-bar at right angles to it. Above the rear end of the truss a weight is carried by a vertical bar on which it is adjustable in order to regulate the period by setting the centre of gravity in any desired relationship to the point of suspension from the spiral spring. The principal part of the mass consists of this counterweight and of a brass box at the forward end of the truss containing a pair of elliptical brass spools on which are wound flat coils; and to a lesser extent of a copper plate supported on a forward extension of the boom or truss, adding to the inertia mass of the moving system. The hinge consists of two pairs of thin crossed springs attached to the hinge-bar of the moving system and to a rigid cross-piece fastened to the frame. The coil-box is free to move between the poles of a large, powerful Alnico magnet. The copper plate moves between the poles of three pairs of commercial Alnico horseshoe magnets, by which critical damping is easily obtained. Wires are led from the coil-box over the frame to the neighbourhood of the hinge-line and thence to a galvanometer. The period chosen in the case of one such instrument used at Saint Louis University lies between the microseisms, which usually have periods of 4–7 sec., and the local traffic disturbances, which have periods less than a second. The magnification is about 3,000. The instrument not only produces good records of local earthquakes, but it will also react to the shorter periods in the beginning of distant earthquakes to such an extent as to produce a sharp record of the beginning where horizontal seismographs of moderate high sensitivity will fail to do so.

Experimental Measurement of Irrigation Water

A PAPER with the title "Medición de las aguas en las estaciones experimentales de riego", by Prof. Juan L. Raggio, with the collaboration of Juan C. Dragonetti and Adolfo E. Foglia, describes the method adopted for measuring with precision the volumes of water used for irrigation purposes at the experimental station attached to the Institute of Mechanics and Hydraulics at the University of Buenos Aires (*Rev. Fac. Agron. y Vet.*, **10**, 111; 1943). An account of the gauges which were used is supplied, and the previous work of Prof. Giulio De Marchi is utilized. He showed how a simple calculation could determine the dimensions of the gauge ("Dispositivi per la misura di quota". *L'Energia Elettrica*, published in 1936–37), and continuing the work on his lines, a study has been made of the hydraulic processes developed in the gauge. A brief description of the irrigation system of the station follows, and a full account is given of the experiments carried out with the gauge to determine the coefficient of expense for various volumes. The paper is illustrated by a number of diagrams and by a chart showing the relation between the theoretical and actual volumes of water and also the coefficient of expense. On the basis of 5·5 litres of water per second, it is shown that the errors existing between the theoretical and actual figures do not exceed 4 per cent. A short appendix deals with the experimental plant on which the agricultural hydraulics of the Faculty of Agriculture of the University of Buenos Aires depends and in which the gauge was utilized.

Differential Corrections to Double Star Orbits

W. P. HIRST has shown how an approximate arithmetical method can be used for applying differential corrections to the elements of the orbit of a double star (*Mon. Not. Roy. Astro. Soc.*, **103**, 6; 1943). The usual procedure for deriving these differential corrections by the method of least squares was criticized some years ago by van den Bos, who pointed out that the result obtained is scarcely worth the work, and also that the elements that make the sum of the squares of the residuals a minimum are not necessarily the most probable (*U.O. Circ.*, 98; 1937). He described in the same issue a graphical method based on the residuals in position angle only. This method consists of plotting the residuals in angle as ordinates against any convenient abscissæ, such as the mean anomaly, or even the serial number of the measure, and comparing this graph in turn with the graphs of the differential coefficients of the equation of condition in angle, plotted against the same abscissæ. The residual curve is corrected differentially after each comparison to remove any systematic resemblance between the residual curve and the coefficient curve. The residual curve is then compared with the next coefficient curve and again corrected, and so on, until no further resemblance with a coefficient curve can be detected. Hirst's method is based on that of van den Bos, but it is much less laborious, and is applied to the orbit of A.417 (A.D.S. 16497). It starts with the function $\delta\theta/\delta e$, which is zero at periastron and apastron, positive from periastron to apastron in the direction of motion, and negative in the other half of its orbit. Hence, if the preliminary value assigned to e is too small there will be, on the average, an excess of positive residuals in the half of the orbit after periastron as compared with those in the half preceding periastron. On this basis, it is shown that very satisfactory results are obtained with much less labour than is involved in the least square method.

MEDICAL DEVELOPMENTS IN FIJI

A FULL report of the address given by Dr. V. W. T. McGusty, director of medical services, Fiji, to the Legislative Council on plans for the future of medicine in Fiji and its neighbouring island groups is given in the *Fiji Times and Herald* of February 24, 1944; and a leading article in the journal warmly commends these plans.

Dr. McGusty also gives in his address a very interesting history of medical progress in that part of the world. It is clear from what he says, from his discussions of his plans with the Colonial Office, from the approval of the plans by the Legislative Council, and from the discussions of the financial requirements of the reorganization proposed, that Fiji is going to incorporate in its medical services the medical developments which are now being organized in the Western world, and that it has both the ability and the personnel to make them as efficient as they are anywhere. The existing medical services are not to be thought of as being in any way primitive. The existing Central Medical School and the Nurses Training Centre and the Central Leper Hospital are joint services in which the New Zealand Government and the American administration of Samoa take part; and the Western Pacific Territories and the Australian Government are also concerned with some of them. All these services are discussed in Council Papers Nos. 2, 3 and 18*.

The difficulties of the medical man in these island groups, his Odysseys in conditions of bad weather and difficult landings in surf-boats, and the remarkably efficient help which the European or American practitioner gets from the keen and well-trained Fijian medical practitioners, are described by Dr. McGusty in this address and also in an article which he contributes to the *Native Medical Practitioner* (Vol. 3, No. 3; Sept. 1941), which is the journal of the Central Medical School, Suva. Other articles in this journal by native medical men and nurses show that Dr. McGusty's praise of them is well founded. There is an eagerness about their writing, and a desire to relieve suffering, which indicates a refreshing and noble realization of their mission. "I hope, sir," one of them writes in his report on seven weeks work on the island of Tongoa, "that you will enjoy reading this brief account of my first start in the New Hebrides." "Hoping," he concludes, "that all the students are working hard at their studies, and with best regards to you, sir, and all the students, your obedient N.M.P. and old student, A. K. Manulevu." What teacher would not be proud to receive such a letter and to do all he can to save such a race from extinction ?

For it amounts to that—no less. "If serious infectious diseases," Dr. McGusty says, "such as malaria, can be kept out of Fiji, the Fijian race may survive." While tuberculosis is still the greatest single disease problem, the danger of the introduction of other diseases which can wipe out populations has always been a menace to Fijian medical care. The geographical position of Fiji renders it likely to become an important junction for civil air traffic after the War, so that its health problems will have more than a local interest. New Zealand is also extending its medical organization and desires closer co-operation with Fiji and the Western Pacific.

Fiji was discovered by Tasman in 1643 and, until the first Europeans arrived at the end of the eighteenth century, the infectious diseases of Western civilization were unknown to Fijians. After 1790, native folk-lore and other sources spoke of epidemics which took toll of a population of some 250,000, but this number had fallen fifty years later to 150,000. Protestant and Catholic missionaries probably introduced diseases, but they were, says Dr. McGusty, the only people who could control them or alleviate suffering, and full credit must be given to them for their work. The cotton boom brought more Europeans and more disease. The late King Cakobau, a very wise ruler, unified the country and led it into the care of Great Britain, to the colonizing power of which Dr. McGusty pays a warm tribute. The Fijian race was nearly wiped out in 1875 by an epidemic of measles which killed 40,000 people. The risk of the introduction of further infectious diseases was, however, vigorously combated by Sir William MacGregor, who instituted strict quarantine barriers, the vaccination of the people and the training of native youths to vaccinate and to practise medicine among their own people. This policy was carried on by Drs. Corney, Lynch and Montague.

The fight against infant mortality, which became serious enough to threaten the progress of the native races, was taken up in earnest, and further increase was checked by Miss Anderson's scheme for training Fijian girls as midwives and nurses. Miss M. L. Lea, principal matron of the Central Nursing School, tells us, in Council Paper No. 18, the history of this school and of its nursing services. Native methods of childbirth and artificial feeding are described in the *Native Medical Practitioner* (Vol. 3, No. 3; 1941), and from these accounts it appears that babies fed entirely on coco-nut prepared in various ways until they are more than eighteen months old may be as healthy as those that are breast-fed. Western methods are, however, rapidly effecting desirable improvements. Dr. McGusty, in his address, pays a high tribute to the work of the experts sent into these island groups by the Rockefeller Foundation, and in particular to the work of Dr. S. M. Lambert. Valuable also has been the opening to other island groups, by courtesy of the New Zealand Government and other authorities, of the Leper Hospital at Makongai. Half the deaths in this hospital in 1942 were Indians, a fact which may be considered together with the fact that the Indian population had, by 1942, risen to within 4,000 of the Fijian, and is expected to overtake and surpass it.

It is clear that the Government's plan to unify the medical services of all these island groups under the control of Fiji will do much to ensure the success of its scheme of improvement. The participation of New Zealand will be invited, and a director-general of public health and medical services for Fiji and the Western Pacific would be appointed, with a deputy director. The scheme includes the building, on a new site with adequate transport and facilities for expansion, of a new central hospital in Fiji of not less than 300 beds, an obstetric hospital of not less than 20 beds, a medical school for 80 medical students including 8 dental students, a nursing school for 150 students and a public health centre. The existing Suva Hospital, which is inadequate in size and equipment, could be altered to accommodate the

* Legislative Council, Fiji. Council Paper No. 18: Annual Report of the Medical Department for 1942. Pp. 24. Council Paper No. 2. Post War Reconstruction: Fiji and Western Pacific. Council Paper No. 3. Report on Public Health and Medical Services in the Colony of Fiji. (Suva: Government Printer, 1943-44.)

Public Health Centre and the administration of the Joint Pacific Public Health Authority and of the Medical Department of Fiji. In addition, it is proposed to use the buildings of the existing Colonial War Memorial Hospital, erected in 1923 to commemorate the fallen in the War of 1914–18, as a new and well-equipped isolation hospital. There will also be four regional hospitals, and the provincial hospitals will be improved. Modern research laboratories, built in 1936 with the help of the Rockefeller Foundation and of Lord Trent, are also available and adequate for present needs.

Of special general interest in view of the precautions which are being taken, all over the world, against the spread of disease in these days of fast transport and aerial travel, are Dr. McGusty's remarks about malaria. Malaria-carrying mosquitoes did not reach Fiji even in the days of sailing ships, although no special precautions were taken to prevent their entry. Dr. McGusty suggests that the south-east trade winds delayed the ships and washed their decks with salt spray, and also that their water-casks were always filled from fast-running streams in which mosquito larvæ did not develop. But the present War has brought an immense volume of traffic by sea and air, and it is a great tribute to the British and United States navy and army authorities that the precautions they have taken have so far kept malaria out of Fiji. How fatal to Fijians its entry might be, and how vital these precautions are, will be realized by those who have read the note in *Nature* of May 20, 1944, p. 625, on the importance of all human parasites in times of war, and on the very serious results which may follow their attack on populations which are not accustomed to them.

Council Paper No. 3, which is a report on the public health and medical services of Fiji made by Dr. Watt, director general of health, New Zealand, and Miss Lambie, director of nursing, New Zealand (the Watt-Lambie Report), illustrates the co-operation between Fiji and New Zealand which the Legislative Council of Fiji wishes to encourage. This report is not merely a report on the health of Fiji; it is also a valuable essay in modern public health practice. Plague and smallpox are, it points out, constant menaces to countries in the Pacific. They can be combated by the quarantine system and measures for rat control recommended by the report and by vaccination for smallpox. The importance of keeping out anopheline mosquitoes is emphasized. The other quarantinable Fijian diseases are yellow fever, cholera and typhus. The recent discovery of the efficacy of *DDT* as a means of killing the lice which transmit typhus and its successful application to large numbers of people in Naples recently should greatly assist the control of this disease in Fiji as well as elsewhere in the world, if, indeed, it does not check its ravages completely. The principal infectious diseases in Fiji are tuberculosis, typhoid fever, dysentery, diphtheria (which is not a major problem) and yaws and hook-worm (which are being well handled).

Tuberculosis is a serious problem in all native races and this report recommends mass miniature radiography, as well as the other measures usually used for its control. Local housing standards are usually good, but it is feared that tuberculosis may increase as the number of town dwellers increases. The pasteurization of milk in the larger communities, or in some places the boiling of it, are recommended, and this should help in the control of tuberculosis as well as that of typhoid and some other illnesses. The control of typhoid and dysentery depends upon safe milk, water and food and on efficient sanitation and general cleanliness. Better supervision of meat supplies and of milk production and improvement of housing, drainage and sewage disposal are required in some areas. The report discusses in some detail the organization and staff of the medical department, the maternal and child-welfare services and the existing hospital services (reports on the last-named constitute an appendix to the report). Other sections of the report deal with the medical, dental and nursing services and with medical and health education. The criticisms of these are, in the main, met by the scheme of reorganization outlined above.

The authors of the report think that Fiji will become a natural centre for medical research and education for the various island groups of the South Pacific. Its excellent climate and freedom from malaria and other tropical diseases should help this development.

Everyone will wish success to the medical authorities of Fiji in the carrying out of this beneficent scheme. The peoples of these island groups deserve all that we can do for them when, before very long, their sunny land will be freed from the shadow which has recently menaced their future. G. LAPAGE.

FEDERAL ACTIVITY IN AMERICAN EDUCATION

IT is not easy, for a non-American, to understand why each of the forty-eight States of America should be educationally autonomous, and why therefore it is difficult for anyone to speak for American education as a whole. This is but one aspect of the opposition between Federal Government and State rights—a matter incomprehensible to a person who is unacquainted with the broad lines of American history and has never travelled in the United States. But war is a national effort, and must be conducted by the nation, in this case with powerful collateral effects upon the forty-eight educational systems. Thus the United States Office of Education at Washington, headed by the U.S. Commissioner of Education, is extremely active, and by the use of the funds provided by the Federal Government for educational purposes is able to promote the ends of a nation at war. So much is made clear by the Annual Reports of the U.S. Office of Education 1941–2 and 1942–3, by the pamphlet entitled "Federal Government Funds for Education 1940–1 and 1941–2", and by the official bi-weekly journal *Education for Victory*, which replaces *School Life* for the duration of the War, and which is specially addressed to all American youth.

Among the war-time causes aided by the U.S. Office of Education agriculture takes a very prominent place, followed by vocational education, vocational rehabilitation, national defence training, library service, adjustment of college curricula to meet war-time needs, teacher personnel problems, not to speak of a long list of less important subjects.

Another way in which the U.S. Office of Education conveniently speaks for America as a nation is exemplified by pamphlets entitled "Inter-American Education: A Curriculum Guide", and "Education in Cuba". The former represents a concerted effort on the part of the U.S. Office of Education to establish a plan for making the study of the other American republics an integral part of the curriculum in primary and secondary schools. The latter is one of several basic studies on education in the other American republics planned as a part of a programme to promote better understanding of education in the Latin-American countries and to encourage closer educational co-operation.

The U.S. Office of Education does not limit its educational surveys to the American continent, but extends them to the wider field of what is known as comparative education. A good example is Leaflet No. 69, which provides a clear and interesting report on "Education in China To-day". The report shows how, despite the invasion of her best developed educational centres, China is to-day demonstrating an unshakable confidence in public education. It seems quite obvious that the Central Office of Education in the United States is doing most valuable work which does not fall within the purview of any one of the forty-eight States.

RESTORATION OF THE LENINGRAD INSTITUTE FOR PLANT CULTURE

By IVAN BONDARENKO*

BEFORE the War, the Leningrad Institute for Plant Culture had formed a valuable collection of seeds of many species of plants. When the siege of the city began, most of the scientific workers were evacuated into the interior of the U.S.S.R., but the seed collection had to be left behind at Leningrad. As soon as the city was freed, the workers returned.

Johann Eichfeld, who came back with a number of assistants, began re-sorting the collection; in the early spring he sent about ten thousand samples of various seeds to different parts of the Soviet Union with the request that they should be planted and a report on the growth furnished to the Institute. Telegrams have already been received reporting results from the Urals, North Caucasus, the Moscow region and Central Asia; in nearly all cases the results have been normal. This shows that, in the main, the collection has not been disturbed, and that with its help new research can be undertaken and the task of helping the restoration of regions devastated by the Germans can be tackled.

The Institute workers are now busy rebuilding their experimental station, which is situated three miles from Pavlovsk near Leningrad. This was formerly a big experimental farm where there were about two hundred varieties of fruits, three thousand varieties of berry fruits (including the only collection of gooseberries in the U.S.S.R.), about fifty thousand hybrid fruit trees and bushes, and many flowers and decorative plants. The station had cherries which ripen quickly in the short summer of this district, with some very fine varieties of strawberries, black-currants, plums and apples.

The German invaders destroyed the greenhouses, laboratories, seed stores, dwelling-houses and other buildings on the station. Many collections of plants were taken away to Germany, and those that were left were badly neglected. People from neighbouring villages and some ex-marines are now helping to rebuild the station.

Under the guidance of Profs. Fedor Teterev and Roman Cordon, houses are being rebuilt and implements repaired. The plantations of shrub fruits and the orchards are being dug over. Seed is being prepared for rapid distribution. It is expected that in the autumn of 1944 and the spring of 1945 the Institute will provide farm nurseries with 100,000 strawberry cuttings, 50,000 young fruit trees, 60,000 currant bushes and many other plants. At the same time, rapid distribution of various plants is being organized so that by next summer some 3,000,000 saplings and cuttings of fruit trees and bushes will be ready. Extensive plans for scientific research work are also being made.

* Transcribed by A. Clifford.

EARTHQUAKES DURING THE SECOND QUARTER OF 1944

DURING April and May, twenty-six strong earthquakes were registered by the instruments at Toledo (Spain), and ten by the seismographs at Wellington, New Zealand. In addition, twenty-five earthquakes were felt by people in some parts of New Zealand. During April 26–June 25, eight epicentres were determined from instrumental evidence by the United States Coast and Geodetic Survey in co-operation with Science Service and the Jesuit Seismological Association. On April 26 an earthquake originated at 1h. 53·9m. G.M.T. from a provisional epicentre at 1° S., 131° E., in western New Guinea. It was registered by the instruments at eleven United States observatories, and also at Toledo and Wellington. An after-shock from the same epicentre had its origin time at 14h. 37·9m. G.M.T. on April 27. This was registered at Toledo and Wellington and was reported from fifteen other stations in the United States, Australia and the Pacific Islands.

The earthquake of May 6 originated at 0h. 13·7m. G.M.T. from an epicentre at 22·4° N., 44·8° W., in mid-Atlantic. It was registered at nine American observatories and at Toledo, but not at Wellington, in any strength. The shock of May 25 at 1h. 06m. 39s. G.M.T. originated at 21·5° S., 179·0° W. in the Tonga Islands, with a depth of focus probably greater than 600 km. It has been reported from sixteen observatories in the United States, Pacific Islands, New Zealand and Toledo. This earthquake was world shaking, and attained a maximum ground amplitude at Toledo of 45 μ. Also on May 25 there occurred another shock at 12h. 58·1m. G.M.T. This time it was from an epicentre at 3° S., 152° E., in New Ireland. It was registered at fourteen stations in the United States, Pacific Islands, New Zealand and Toledo.

On June 16 an earthquake was registered at nine American observatories, and its epicentre as provisionally determined by the U.S. Coast and Geodetic Survey was at lat. 19° N., long. 105° W. Its origin time was 21h. 51·5m. G.M.T. The shock of June 21 originated in the New Hebrides (21·5° S., 169·8° E.) at 10h. 58·3m. G.M.T., and that of June 25 originated in mid-Atlantic (1° S., 25° W.) at 17h. 42·2m. G.M.T. according to the determination based on reports from Fordham, Huancayo, San Juan and Spring Hill.

In New Zealand the strongest earthquakes to be felt had strength IV on the modified Mercalli scale. These were reported as follows: April 17 at Porangahau, April 22 at Blenheim, Cook Strait and Wellington, April 30 at Tolaga Bay, May 16 in the Takaka region and May 20 at Rotorua. On May 9 an earth tremor was felt at Wairoa and Napier with scale III, and some inhabitants of Napier again felt a shock with scale III on May 31.

FORTHCOMING EVENTS

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

Saturday, September 30

SHEFFIELD METALLURGICAL ASSOCIATION (at 198 West Street, Sheffield 1), at 2.30 p.m.—Prof. F. C. Thompson: "Some Fundamental Work on Austempering and the Isothermal Transformation of Austenite".

Monday, October 2

SOCIETY OF CHEMICAL INDUSTRY (YORKSHIRE SECTION) (at the Metropole Hotel, King Street, Leeds), at 6 p.m.—Dr. A. L. Roberts: "Drying by Infra-Red Radiation".

Tuesday, October 3

CHADWICK LECTURE (at the Royal Society of Tropical Medicine and Hygiene, 26 Portland Place, London, W.1), at 2.30 p.m.—The Rt. Hon. Lord Amulree: "Water Supplies in Peace and War".*

Wednesday, October 4

INSTITUTE OF FUEL (at the Institution of Mechanical Engineers, Storey's Gate, St. James's Park, London, S.W.1), at 2.30 p.m.—Dr. H. R. Fehling: "Thermal Insulation".

ROYAL ENTOMOLOGICAL SOCIETY OF LONDON (at 41 Queen's Gate, South Kensington, London, S.W.7), at 3.30 p.m.—Mr. E. D. Eyles: Film of House-fly Alighting on Ceiling.

SOCIETY OF PUBLIC ANALYSTS AND OTHER ANALYTICAL CHEMISTS (at the Chemical Society, Burlington House, Piccadilly, London, W.1), at 2.15 p.m.—Inaugural Meeting of the Micro-chemical Group: at 3 p.m.—Dr. Janet W. Matthews: "The Development of Micro Methods in Analytical Chemistry"; at 3.45 p.m.—Dr. A. A. Houghton: "The Micro-determination of Carbon by Wet Combustion".

Thursday, October 5

INSTITUTION OF ELECTRICAL ENGINEERS (at Savoy Place, Victoria Embankment, London, W.C.2), at 5.30 p.m.—Sir Harry Railing: Inaugural Address.

Friday, October 6

ASSOCIATION OF APPLIED BIOLOGISTS (at the London School of Hygiene and Tropical Medicine, Keppel Street, London, W.C.1), at 11.30 a.m.—Dr. J. W. Evans: "Applied Biology in Tasmania"; Dr. C. B. Williams: "Applied Entomology in South America".

Saturday, October 7

GEOLOGISTS' ASSOCIATION (at the Geological Society of London, Burlington House, Piccadilly, London, W.1), at 2.30 p.m.—Mr. A. D. Lacaille: "The Northward March of Palæolithic Man in Britain".

REPORTS and other PUBLICATIONS

(*not included in the monthly Books Supplement*)

Great Britain and Ireland

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