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RELATION OF SCIENCE TO POLITICS

THE value of the Conference on Science and World Order in London last September lies largely in its emphasis on the increasingly close relation between science and government. For all its demonstration of the contribution which science could offer to the solution of the many problems of human welfare involved in the realization of the four freedoms, the Conference is more significant for the evidence it affords that the fundamental problem is that of securing the right relations between science and government. The full resources of science must be brought to bear on the problems of human welfare without impairing the freedom of thought, investigation and teaching upon which the very existence of science depends. While the independence of science is thus safeguarded, means must be found for securing the effective application of the knowledge acquired by disinterested and impartial research to the solution of social and economic problems and the service of human needs. The problem of the relation of knowledge and action is once again demanding an answer in terms of the needs of to-day and not the traditions of yesterday.

The discussions which have taken place since the Conference, and centring to some extent around the presidential address of Sir Henry Dale at the recent anniversary meeting of the Royal Society, on the relation of science to politics, like the conferences on science and the war effort convened by the Association of Scientific Workers, attest that the Declaration of Scientific Principles has been taken to heart by scientific workers. Conscious of the dangers to science and society inherent in the relations between science and politics, they are seeking to determine the conditions of advance. That much at least lies behind the various proposals regarding the organization of research in the social sciences and the establishment of a central institution for that purpose.

The address on Science and International Politics which was delivered by Sir Richard Gregory at the Royal Institute of International Affairs on February 2 (see p. 261 of this issue) should go far to clarify thought on this subject, which certainly must not be shunned because it bristles with difficulties and dangers. Admittedly there are departments of civil life which could with advantage make fuller and more systematic use of the scientific methods of inquiry into the factors which determine human conditions and potentialities to-day. To turn our back deliberately on such possibilities and to make no attempt to use that scientific knowledge which is our greatest power for social and political action is to deprive the Atlantic Charter of meaning, if not indeed to endanger the winning of the War itself.

Once we admit, as Sir Richard points out, that there are political leaders who can scarcely be said to take account of the changing conditions of life due to the applications of new scientific knowledge, either in the present or for the future, scientific workers can not rest content as citizens. They must make some effort to influence those in charge of the forces of science and who carry the responsibility of seeing that these are used effectively for the progressive welfare of the community. They must at least attempt to secure that the strength and disposition of the forces of science are given full consideration in all social and political campaigns. The fact that, as Sir Richard points out, few men of science feel able to transfer their trained habits of thought, does not absolve the body of scientific workers, either corporately or individually, from the responsibility of attempting to transfer to the consideration of social and political problems their training to face facts before arriving at judgments.

This, of course, is exactly what General Smuts urged in his Sidgwick Lecture on Democracy. It is only by applying to political problems the principles of independent inquiry and impartial judgment demanded of investigators in all branches of natural knowledge that politics can become a science and scientific workers as such can contribute to its advancement. Without this spirit and purpose, science and politics are best placed in different categories.

What has marked numerous discussions on social and economic questions of recent years is, however, the extent to which by making action possible on the basis of ascertained facts, science has taken problems out of the purview of party politics. Nutrition is an outstanding example of this kind. Political action is still required, but the question is no longer a party issue, and the power to be applied is that required to overcome vested or private interests as opposed to those of the community.

The natural extension of the boundaries of knowledge by the application of scientific method may thus, it is true, gradually extend the field within which action free from political prejudice is possible. We can not, however, rely on that process alone if effective action is to be taken to deal with many of our more urgent social problems before they bring worse in their train, any more than we should imagine that the scientific method alone will provide a solution. The effective implementation of this process involves three desiderata, with each of which the scientific worker is concerned: leaders and administrators competent to assess the results of scientific work and ready to apply them to the solution of the problems of to-day; a body of active younger scientific workers not merely extending the boundaries of knowledge but also able to formulate the questions to be asked, the problems to be attacked; and a body of public opinion sufficiently informed and powerful to overcome the opposition of any sectional interest to policies or action initiated in the general interest.

Prof. A. V. Hill's address last year to the annual general meeting of the Parliamentary and Scientific Committee contained specific proposals for forwarding the second of these needs, and the Scientific Advisory Committee, of which Lord Hankey is chairman, may yet do much to implement the first. It is the third condition, with the implied task of educating public opinion, that is possibly the most fundamental of all and which has yet to receive the attention it deserves from public opinion. Sir Richard Gregory's address is a contribution in this field which once again should earn him the gratitude of scientific workers.

There is, however, a further point to which Sir Richard directs attention. Repeatedly observers have noted the difference between the success of the League of Nations in its non-political work such as that of the International Health Organis tion or the Opium Commission where technical considerations were the dominant factor, and its failure in those dominated by politics. Sir Richard suggests that international politics in which the world is a unit, of which all men are citizens with rights and duties to be adjusted wisely with the object of ensuring progressive development everywhere, is the field into which the international spirit of science can enter without being regarded as an intruder or becoming involved in controversial national politics. National boundaries have little relation to the distribution of national resources and less to the needs of modern life. All communities can share in the achievements of scientific discovery and invention, and the tendency towards larger political units gives promise of further expansion into a commonwealth of the chief free peoples of the world.

Such a commonwealth can only be secured by consent, and as Sir Richard reminds us, no new world order can be stable unless each nation is free to follow its own lines of cultural development, and does not seek to deprive others of the same liberty. With such a co-operative alliance in mind—already embryonic in the fourth point of the Atlantic Charter —the services of science can be used to shape the course of international politics. As already noted, advancing knowledge is taking welfare policy out of the field of party politics both in the national and in the international spheres. Knowledge of natural objects and phenomena is the foundation upon which modern civilization is based. It is continually revealing new sources of supply of materials and power to expand this structure. Applied science has provided the means of making the world's abundance available to all men, and the aim of international politics should be to see that the supply is adjusted according to the need for its use.

Such an outlook on world order is as implicit in the Atlantic Charter as in the four freedoms of President Roosevelt, and it should already be clear that its realization depends very really on the co-operation of men of science. While, however, what exists in the world, and what uses can be made of it, are discovered by scientific inquiry, what action is taken on this basis depends upon communities and their governments. For this reason the view that the sole function of men of science is to study and discover natural facts and principles without regard to their social implications is no longer tenable. Not only have they special responsibility for recording their opinion in matters in which their pursuits affect the welfare of the community, but also the obligation as citizens to assist in the establishment of a rational and harmonious social order out of the welter of human conflict into which the world has been thrown because the powers they have released have not been rightly used in the service of mankind as a whole.

It is at this point that Sir Richard's address is linked up with an article "Science to Re-build" in the November issue of *Current Science* (India). Admittedly the Atlantic Charter gives new hope for the establishment of a world order in which the fundamental rights of men and communities will be defined and acknowledged and in which science will be able to serve more effectively the needs of mankind. Such rights and principles must, however, be formulated more clearly than has yet been done if reconstruction is to prove effective, and science can well combine with politics, as Sir Richard suggests, in the determination of such principles and in arriving at a sound basis for the constitution and judgments of a court of international politics.

The article in *Current Science* indicates further steps to be taken, notably in the extension of scientific knowledge in those fields where it would assist man to acquire control over his own nature corresponding with his control over material resources. Besides, it is essential that even such declarations as the Atlantic Charter should be submitted to careful and scientific scrutiny. Already there have been some differences of interpretation of, or at least of emphasis on, the various clauses and if misunderstandings are to be avoided certain of these points must be elucidated in the near future.

In the modern world to-day not even an Anglo-American declaration of policy can avoid facing the colour question, and the article in *Current Science* is on firm ground in directing attention to the omission of any reference to such countries as India, and again in insisting that the first axiom in world planning is that the prime motive force of life is hunger, which knows no distinction of colour. No world order which does not take into account the needs of coloured as well as of the white races can be regarded as either scientific or durable.

On other specific points of the Atlantic Charter this article is equally searching. In regard to territorial settlements it points out that an expert body of economists, demographers and other specialists will be required to furnish the necessary advice on particular settlements if such settlements are to be free from any sense of unfairness. It challenges the durability of any settlement respecting the right of all peoples to choose the form of government under which they will live, unless in practice that government is some form of democracy. It raises the question of the responsibility of scientific men in respect of disarmament with reference to work likely to be useful for military purposes, and suggests that such researches should be submitted for examination and their report on results for control by an international agency.

In the field of economic development some of the implications of the Charter are indicated, such as open markets, the supply of technical knowledge and skill and industrial machinery, and an international bank or finance corporation to lend money for development purposes, free from political, military or trading obligations.

It is abundantly clear that there is an immense field in which fundamental thinking is required before we can implement many of the principles of the Atlantic Charter or assess rightly the schemes of reconstruction which must be worked out in readiness even in the dark and exacting days of war. To that thinking science has much to contribute. Corporately and individually scientific workers can also do much to forward the task of reconstruction in fields where they bear special responsibility, as has already been recognized by engineers, physicists, medical men and architects in the formation of special planning committees or commissions. There are, however, many sections of scientific workers who have shown little sign of recognition of their responsibility in this field and it may well be hoped that Sir Richard Gregory's address will not only stimulate such to action, but also scientific workers generally, to consider more carefully the appropriateness and effectiveness of the machinery which already exists for integrating the relations of science and politics, whether at the top in the Scientific Advisory Committee, in the arrangements for widening the outlook and experience of the active young minds engaged in scientific work, to which Prof. A. V. Hill has specially referred, or in that fundamental task of educating the public mind so that it can reach sound decisions and supply the power to overcome private interests which hold up action demanded by the public interest. As these lines are explored with the world vision and perspective which Sir Richard emphasizes, the relations between science and politics will become more clearly delineated, while the claims of science to be free from any form of pressure in pursuing her work are established beyond challenge.

SKILLED MAN-POWER IN THE SERVICES

THE importance of wise utilization of skilled man-power if we are to develop the maximum production and war effort has been emphasized by recent events, and its realization has been implicit throughout recent debates and discussions in Parliament and elsewhere. If the second report of the Beveridge Committee on Skilled Men in the Services* will not altogether dispel misgivings on that ground, there are certain points on which it gives welcome reassurance.

The Committee is able to answer unhesitatingly that the Navy is using the skilled man-power at its disposal with due economy and effect, except in regard to naval reservists, where the measures already taken for transfer of qualified men to skilled work need to be repeated and reinforced until they achieve success. Better use is being made of skilled engineers in the Navy than in either the Army or Air Force. Although the problems in the Navy are simpler, they would not be solved as completely as they are, unless the Navy possessed, as it does, good

* Committee on Skilled Men in the Services: Second Report and a Memorandum by the War Office. Pp. 74. (London: H. M. Stationery Office, 1942.) 1*s*. 3*d*. net.

arrangements in respect of trade testing, search for talent, technical training, review of establishments, interim use of engineers and self-scrutiny. The trade testing of the Navy is centralized, standardized, and objective. Any skilled engineer volunteering for the Navy knows that he will have a fair test, and that if he passes, he will be ranked forthwith as a petty officer and employed as an engineer. There is organized search for talent in the Navy and, while in the development of new training establishments the Navy has less to show than either of the other Services, the regular establishments are excellent and their procedure has been adjusted to war conditions. By better use of some of the naval reservists, the Committee estimates that it should be possible to meet some 10 per cent of the demands of the Navy for skilled men during the period ending March 31, 1942, but substantial additional numbers will be required.

The Air Force stands intermediate between the older Services, in size, in rate of expansion, and in the complexity of its problems. It is also not so clear of complaints of unused skill as is the Navy; but, while it has nothing comparable in scale to the misfits and misapplications that appear in some parts of the Army, it shows sufficient misfits to call for expansion of the measures which have already been taken to deal with such cases. The Committee considers that the machinery for sorting, selecting and trade testing should be re-examined, and such barriers as remain should be reconsidered.

The situation with regard to the Army is less satisfactory, and substantial changes of organization and machinery are likely to be required before it can be said that the skilled man-power already at the disposal of this Service is being used with due economy and effect. There are, of course, several factors which have made the adjustment of supply to demand and full use of skilled men harder for the Army than it is for either of the other Services, or for civilian industry. The Army has expanded more than either of the other Services and much more than the munitions industries, and its rate of growth has been subject to violent fluctuations. An industrial organization which after a comparable period of growth was subjected to a similarly thorough scrutiny would be lucky it it failed to show many misfits.

At the beginning of the War, the Army received numbers of men, either called up as territorials and reservists or posted as militia, in regard to whom it was not possible to exercise selection in assigning them to appropriate trades or units. In addition, the Army, while growing, has had to change its character by progressive increase in the proportions of armoured and mechanized divisions. The character of the War, with the serious loss of equipment in France and the subsequent prolonged restoration and waiting in England, have added to the difficulties of adequate use of the man-power in the Army, but one of the most fundamental difficulties is the structure of the Army as a combination of distinct corps and of units, often with strong local associations or sectional traditions, and consequent obstacles to transfer.

All the investigations of the Committee point to the conclusion that the reservoir of unused engineering skill already in the Army is greater than the revised requirements for skilled men of engineering and allied occupations laid before it by the War Office. While this does not mean that all such requirements can be met from within the Army, it does involve certain major changes, notably the technical review of establishments, the pooling of mechanical reserves, and the reorganization of selecting, sorting and trade-testing arrangements. The older Army training establishments are regarded as excellent. Its new training establishments are an improvisation deserving of great praise; good in themselves, they need to be fitted more closely into the organization of the Army as a whole, with better selection of trainees and with closer adjustment to the practical problems which the trainees will have to solve.

The report advances two major proposals for consideration, rather than as recommendations: enlistment into the Army not for corps, but as a single Service; and the establishment of a Corps of Mechanical Engineers. Fundamental to this and to the vital changes recommended, and a condition of their achievement, is that mechanical and electrical engineering, as distinct from civil engineering, should be given their proper place and authority in the higher councils of the Army. Review of establishments on the lines suggested may achieve substantial economies of skilled men in the Army without undue risk, but the vital need is for a new outlook, for new methods for new tasks. Mechanization of an army, as the Committee observes, should begin from the top.

When full allowance has been made for all disturbing factors, and in spite of the vigorous efforts made in all three Services to bring about a re-mustering and using of men according to their skill, the extent to which men of rare skill find that skill unused in the Forces, in the Committee's judgment, remains disturbing and surprising. It is fully recognized that many forms of skill which are valuable in peace cannot be turned to account in war, and that the essential problem of skilled men in the Services is that of how to be ready for emergencies without wasting more than the irreducible minimum of skill in standing-by. The organization of war is largely a question of priorities, and in regard to engineers the Committee has been guided by two principles: the first priority in war is for whatever may be needed to keep the machines of war in action; and second, in war engineers are for those who can and will use them as engineers.

The Committee points out that, on the first principle, skilled engineers and spare parts are alternative means of securing the maintenance of machines of war, and its lucid argument shows a clearer grasp than the War Office in its accompanying memorandum of what General Wavell termed the "mechanism of war" and the real foundation of military knowledge in his lectures on "Generals and Generalship". While, therefore, the full investigations leave unchanged the main conclusion of the interim report that an increase in the skilled personnel of the

Services is inevitable, and that more engineers must be drawn from civilian industry for the Services, there is a clear possibility that the unused reservoir of engineering skill in the Army is large enough and varied enough to meet all the requirements submitted to the Committee for men of engineering skill.

The whole tone of the War Office memorandum published with the report betrays a disquieting failure to see the situation in its true perspective of either time or resources, and the subsequent speech by the Secretary of State for War in the House of Commons was even less reassuring. Some of the points raised in the War Office memorandum deserve careful consideration, but a frame of mind and a condition of organization which have already taken three and a half months to produce this memorandum on the report with the remark that so important a recommendation as the creation of a Corps of Mechanical Engineers is still under consideration are profoundly disturbing. The War Office cannot avoid the issue by the naive suggestion that the Beveridge Committee brings to its task merely the standards of industrial practice. The problem of a trained, equipped and maintained army and its industrial background must be seen as a whole, and if the Army's present leaders cannot see the problem thus and weed out wasters as well as waste at every rank, they must be replaced by those who can.

It should not be thought, however, that in spite of the procrastination of the higher command in dealing with the two major proposals, the Army is making no attempt at a more scientific use of its resources of man-power, skilled or unskilled. Lieut.-General Sir Ronald Adam recently gave an encouraging account of the selection tests for avoiding misfits which have already been developed under the Advisory Committee, composed of Prof. J. Drever, Dr. C. S. Myers, Prof. F. C. Bartlett and Prof. C. Burt, appointed last June to assist the Director of Personnel Selection. Moreover, a thorough analysis is being made of every job in the Army and experiments are being made in leadership tests, based to some extent on German practice, for use in selecting men for training as officers, and directed to ensuring that a leader is more intelligent, has quicker reactions and more personality than the men he leads.

General Adams's statement that a large-scale experiment has been started by enlisting men into a general service corps and putting them through a basic training course before deciding for which corps they are best suited indicates a greater receptivity to new ideas than is apparent in the War Office memorandum.

A more promising attitude is also to be found in the War Office observations on the twenty-second Report of the Select Committee on National Expenditure, which have now appeared in the Select Committee's first report of the 1941–42 Series. The memorandum states that the directorate of Selection of Personnel has a staff of 15 officers and 150 N.C.O.s (including A.T.S.) and has been approved to carry out selection tests on the personnel both of intakes and of existing units. While upholding the value of the military interview, the memorandum recognizes that the selection test is complementary and that the value of the interview will be greatly increased if the interviewing officer has before him the result of the man's selection test. The War Office would welcome a system of compulsory intelligence testing of all intakes, regardless of their preference, to be carried out under the auspices of the Ministry of Labour.

Discussing the Select Committee's recommendation for the establishment of central depots for classification before posting, the same argument is advanced as that against the proposal of the Beveridge Committee, but it is admitted that the basic training centre system is already in use for the A.T.S. As regards the discharge of unsuitable personnel, the War Office urges that this must be weighed carefully against the man-power situation. The War Office agrees that intelligence is one of the principal factors in the make-up of a potential officer, and that no candidate should be sent to an officer cadet training unit whose intelligence as measured by a test does not reach a certain standard. The time to apply such a test is under investigation, and it is proposed that all candidates should be given an intelligence test before their interview by a Command Interviewing Board.

These observations will do something to reassure opinion as to the readiness of the Army to rectify past mistakes and improve its technique and organization in these vital matters. Sir Edward Grigg's speech following Capt. Margesson's in the debate on the Army Estimates, was, however, somewhat disturbing from the point of view of the outlook betrayed. The statement that only 9 per cent of officers in the Army had had a university education can reflect equally on the capacity of the universities to train men for leadership and on the ability of the Army to recognize potential leaders. But it cannot be discussed without some knowledge of the numbers of university men available for meeting Army requirements and of the extent and nature of the Army's requirements for officers.

The statement should not be allowed to pass unnoticed, because of the implication contained in the whole context that a high standard of education is unnecessary in meeting Army requirements. Fundamentally, it may well be found that the blows which we have recently suffered are due at least in part to defects of leadership from top to bottom of the Services, which can in turn be traced to the neglect and indifference of people and Government alike to the real issues of education. Sir Edward Grigg fundamentally misconstrued the attack on recruitment of officers from the public schools. The objection to that system is that it places recruitment on a class basis, and does not tap the larger reserves of leadership available in the nation. Moreover, until some system of intelligence test is imposed in accordance with the War Office memorandum, on all entrants to officers training establishments, from Sandhurst and Woolwich downwards, there will be no satisfactory obstacle to such factors as social or economic position admitting men ultimately to positions of responsibility which they lack the character or ability to discharge.

The appearance of the Beveridge Report and the accompanying memorandum, however, should not be without a steadying influence on the public mind. They represent a great challenge to constructive thought which scientific workers should be quick to accept. Their implications strike far into the causes of our present difficulties, and there are few indeed who cannot see in this analysis some bearing on their own task and part in the war effort, and an indication of how that contribution can be increased. The solid reasons for confidence contained in the Report, and the picture of admirable work already being done, only emphasize the urgency for doing quickly what more remains to be done. On every citizen lies the responsibility for seeing that there is no waste of skill, men or material, and when he has done his or her utmost in his own special sphere, there lies that corporate responsibility of compelling effective and urgent action, through Parliament and the sheer force of public opinion, wherever indifference, neglect, incompetence or lack of interest perpetuates inefficiency and waste.

FIREFLIES

Living Light

By E. Newton Harvey. Pp. xv+328. (Princeton, N.J.: Princeton University Press; London: Oxford University Press, 1940.) 24*s*. net.

A GLOW-WORM in the grass and fire dripping from the oar are two things which once seen are never to be forgotten. Faraday, posting through Italy with Sir Humphry Davy, found "entertainment and delight" in the fireflies by the way. When the *Challenger* entered the Guinea Current, soon after her voyage began, the sea was "a perfect blaze of phosphorescence"; and long afterwards Wyville Thomson used to tell us how the Pyrosomas glowed in the water like bars of white-hot steel. Sir Joseph Banks had found his *Medusa pellucens* (akin to our *Pelagia noctiluca*) in the same waters, and thought it the most splendid of the luminous inhabitants of the ocean; its flashes of light, he said, were so vivid as to affect the sight of the observer. And Humboldt speaks with his great voice of that "magic brightness", which is part of the joy of those who, like himself, have a peculiar predilection for the sea.

The shellfish (Pholas) which, according to Pliny, seem on fire as they go down your throat—*velut igne lucentes in tenebris, etiam in ore mandentium*; the splendid brief intensity of the Bermuda fireworm; the little lanterns of the deep-sea fish which the dredge brings up and which Dr. Beebe goes down to see; the little squid at Messina which surround themselves with liquid fire instead of a screen of ink—all these are part of the multitudinous phenomenon which Prof. Newton Harvey lovingly and enthusiastically describes. Every now and then our wonderment grows greater still over some new feature of the display, such as the flashing of certain fireflies in periodic synchronism. "At one time [in Siam] every leaf and branch appears decorated with diamond-like fire; but soon there is darkness, to be again succeeded by flashes from innumerable lamps."

For thirty years at least Prof. Newton Harvey and the students in his Princeton laboratory have been studying the phenomena of luminescence. They have turned out among them a host of well-known papers, and his friend, Prof. Ulric Dahlgren, has been as busy on the histological side as Prof. Harvey on the experimental and biochemical; indeed, Prof. Harvey seems just a little weighed down in the writing of this book by the superabundance of his own knowledge. He gives us a useful bibliography of some thirty pages; but this, he tells us, is a mere nothing, so vast is the literature of the subject. A hundred years ago, in his famous work, "Das Leuchten des Meeres", Ehrenberg cited between four and five hundred older books and papers, very few of which Prof. Harvey finds room, or thinks it necessary, to quote again.

But to sum up. After giving a third of his book to the description of all manner of phosphorescent organisms, Prof. Harvey goes on to deal with the physics, the chemistry and the physiology of the subject. He describes the various types of luminescence from the physicist's point of view. He goes on to the chemistry of luminescence, and is particularly interested in the curious substance described sixty years ago by Dubois as luciferine, along with its enzyme luciferase. An interesting chapter follows on the physiology of luminescence; and the last chapter of all (which interests me less) is on the physical nature of light. Of the many illustrations, some are curiously beautiful, especially the frontispiece, which shows some of Dr. Beebe's deep-sea fishes in pursuit of little scarlet and luminous squid.

The author is generous in crediting to its discoverer almost every fact which he records; but it cramps his literary style somewhat to quote fifteen or eighteen authors on a page, along with the dates of their several publications. The book has its share of misprints, but its blunders, so far as I can see, are few. The Nemertean worms are not so called from the 'unerring' aim of their proboscides, but merely as a literary allusion to Hesiod's description of the father of all the Nereids, the wise Old Man of the Sea. And as to Fulgora, whose time-honoured reputation as a 'lantern-fly' now comes in question, it would be all very well to call it a 'bug', but to call it a *beetle* won't do.

D'Arcy W. Thompson.

THE LIVING SPIDER

The Comity of Spiders

By Dr. William Syer Bristowe. Vol. 2. (Ray Society Volume for the Year 1940.) Pp. xiv+229–560+3 plates. (London: Bernard Quaritch, Ltd., 1941.) 25*s*. net.

ALTHOUGH Dr. Bristowe writes in his preface that the War has affected his work on spiders and even his enthusiasm it is difficult for the reader to detect many signs of this in the volume which concludes the work first published in 1939. The subjects with which he is now concerned are food and its capture, danger and its avoidance, courtship and mating. On these matters he gives us a summary of his own investigations—which began, he tells us, at the age of four—supplemented by some contributions from the work of other araneologists.

In the first chapter, which deals with the capture of the prey, Dr. Bristowe analyses the varied methods employed, classifies the types of web and gives his views on the difficult subject of the evolution of the web. The clue that he offers in solving this problem is the suggestion that silk was first used as a protective cover for the eggs; at the same time the tracing of the evolutionary path is complicated by the fact that the same type of web may more than once have arisen independently.

In discussing the nature of spiders' food, Dr. Bristowe corrects the vague impression that spiders generally will eat any small living animal. He does this by a very full account of experiments on the acceptance or refusal of many insects and other arthropods by many kinds of spider. The insects are passed in review, order by order, and precise information is given of the results of offering them to spiders of many genera. Usually the actual species of spider and of insect are recorded, and the result is a large body of exact and reliable information on a subject which has not previously attracted the attention it is now shown to deserve. One of the most interesting of the many points emphasized is the fact that often, after biting and rejecting a nauseous insect, the spider is seen to "wipe its mouth" on a convenient leaf or the neighbouring wall.

Dr. Bristowe next turns his attention to the opposite side of the picture: from those animals a spider will eat to the correlative question of the animals that will eat a spider. The same admirably precise information is recorded. The enemies, parasites and predators are taken order by order. The longest sections here are concerned with Ichneumons and other spiders among invertebrates, with fish and birds among vertebrates. The great popularity of ornithology enables quantitative estimates to be given here, and the section concludes with a striking table of the estimated spider-consumption of sixteen species of British birds. These range from starlings, credited with a total consumption of 10,000 million spiders annually, to rooks, which are responsible for a mere twenty-five million. The spider's protection against its enemies seems to be chiefly the well-tried methods of protective resemblance and mimicry.

In the chapter on mating habits Dr. Bristowe is writing on a subject that he has made peculiarly his own. He now gives us a survey of the whole process, from the remarkable sperm-induction to the male spider's chance of escaping from his mate with his life.

Dr. Bristowe dedicates this second volume to the naturalists of all nations, and this fact, together with the curious title of the book, may be taken as an expression of his intention to write as a naturalist rather than as a biologist or a zoologist. In so doing he has shown that it is possible to learn a great deal about the habits of animals and to understand, so far as that may be done, something of their mode of life, without the use of any theory of animal behaviour. He is concerned only to describe events, and he does so in a manner that, while he now avoids anthropomorphic and specifically teleological statements, gives a picturesque and even an exciting impression of what he has seen. But he refrains from debate as to whether reflex, tropistic or instinctive behaviour gives the best method of scientific description of any activity.

In his last chapter, however, he deals with a question of broader biological significance, namely, the dominance of Linyphiid spiders in temperate regions. He concludes that this is due to the favourable climate, the abundant food supply and a partial immunity from the attacks of some of the spider's enemies.

The book is illustrated chiefly by clear line diagrams with a few photographic plates, which, it must be confessed, demonstrate the marked superiority of line over photography where spiders are concerned. A word of praise should be given to the apt choice of unusual quotations which have provided the chapter mottoes. Nor should the industry which has compiled the very useful index of every specific name used in British spider literature be unmentioned.

Taken together, Dr. Bristowe's two volumes constitute a notable piece of work and one which should facilitate and encourage the study of British spiders when international affairs once more permit the prosecution of peace-time occupations.

T. H. Savory.

FOURIER SERIES AND SOME APPLICATIONS

Fourier Series and Boundary Value Problems

By Prof. Ruel V. Churchill. Pp. ix+206. (New York and London: McGraw-Hill Book Co., Inc., 1941.) 17*s.* 6*d.*

In the development of human knowledge, and particularly in science and mathematics, any great discovery stands out as a beacon to mark progress made in a certain direction. But it reveals also paths of possible further advance upon which other research workers may begin to tread. In time, these workers may light up new beacons until a whole region becomes illuminated with increasing intensity. The discrete points of light thus tend to lose their separate identities by merging themselves into a flaming torch—discontinuity seems, in fact, to become continuity. So, in particular, one great mathematical discovery opens the way for many others until previously accepted concepts become broadened into a much more powerful generalization which, as history reveals, so absorbs the contributory steps that they almost lose their individual entities. This fact is well illustrated by the subject of the volume under review.

While trigonometric series were first introduced in analysis by Daniel Bernoulli and Euler in connexion with problems on vibration, and by Legendre and Laplace in the theory of gravitational potential, it was the great work of J. B. J. Fourier (1768–1830), in showing that quite arbitrary discontinuous curves could be represented analytically by means of infinite trigonometric series, that opened the way to laying the subject upon a sure foundation. In the process, as Boyer remarks[1], "the attitude towards the function concept became broader". This was made manifest by the subsequent work of Cauchy in which a new notion of continuity was developed. One modern writer has declared[2] that the theory of Fourier series is "one of the most beautiful results of analysis and serves as an indispensable instrument in the treatment of nearly every physical problem".

Prof. Churchill's volume admirably illustrates this truth although the author only claims his book to be an introduction to the subject. It is concerned with the two related and general problems: the expansion of an arbitrary function into a Fourier series, and the boundary value problems in the partial differential equations of physics and engineering. Before dealing with the essential theory of the Fourier series, the first three chapters are devoted to an introduction to the subject, the partial differential equations of physics and a succinct account of orthogonal sets of functions. Chapters 4 and 5 treat of the Fourier series proper, their various forms, fundamental properties and Fourier integrals, all of which are well discussed. Applications to boundary value problems then follow as the main subject-matter of the remaining four chapters. In these, the essential theoretical aspect, such as uniform convergence, uniqueness theorems, etc., are considered in their relation to the solution of the important problems connected with vibration, temperature, electric potential, and so on. Finally, Bessel functions and Legendre polynomials, with their respective applications to radiation, vibration and gravitational potential due to a circular plate, bring a very interesting and instructive course to a conclusion.

The book is excellently printed and abounds in illustrative examples and problems in wide variety for the student. Answers to most of the latter are provided, and references for further reading are given at the ends of most of the chapters.

The author's aim to render the course "both elementary and mathematically sound" has been skilfully carried out and the book is a valuable contribution to the subject.

[1] Boyer, "The Concepts of the Calculus", p. 277 (New York: Columbia Press, 1939).

[2] Sokolinkoff, "Higher Mathematics for Engineers and Physicists", p. 135.

POLYMERIC REACTIONS

High Polymeric Reactions

Their Theory and Practice. By Prof. H. Mark and R. Raff. Translated from the Manuscript by Luise Harris Weissberger and I. P. Irany. (High Polymers, Vol. 3.) Pp. xiii+476. (New York: Interscience Publishers, Inc.; London: Imperia Book Co., Ltd., 1941.) 39*s*. net.

THIS is the first book exclusively devoted to an examination of the mechanism of polymerization reactions. Such reactions can now be well enough controlled to make practicable quantitative measurements on the rate processes involved. Consequently it becomes possible to inquire how chemical kinetics can throw light on the nature of the elementary types of reaction in the polymerization mechanism. In this respect it is a virgin field, and in spite of considerable effort there is still much to be done before a clear and reliable picture of polymerization may be constructed.

Admittedly the problem is much simplified by the development of the detailed theory of chain reactions started some fifteen years ago, but the theory of polymerization reactions has to do a good deal more than the straightforward chain theory. Here in essence it was necessary to deal with only two active molecules or chain propagators, and establish their identity and reaction velocity coefficients. With polymer reactions, on the other hand, the nature and reactivity of *each* polymer must be determined not only as a matter of kinetic interest but also as a prerequisite in calculating concentrations of the several polymers formed after the reaction has ceased. In addition, there are further complications. Linear chain polymers are not necessarily built up by a chain type of mechanism in the sense that one molecule of catalyst may induce the polymerization of many molecules of monomer. For example, in polycondensations it is certain that the polymer is built up step by step by a series of essentially similar reactions. Again, it is found in some reactions that, once started, they seem to proceed indefinitely provided monomer is continuously supplied to the growing polymer. The result is that the convenient and powerful stationary state method of analysis cannot be applied. Complexity reaches its peak when, to any one of these processes, are added the phenomena of the branching and subsequent cross-linking of the linear chains to form three-dimensional networks. Explosive or indefinitely rapid polymerization has not so far been observed, and hence the theory of branching chains provides no help at present.

It is therefore no mean task to devise methods which will yield quantitative information about the molecular statistics of so diverse a series of processes. The volume under review gives a description of the efforts that have been made in recent years to tackle some of these problems. The first part gives an account of the structure of high polymers and their physical and chemical characteristics. There follows next a comprehensive description of the experimental methods employed to trace the course of polymer reactions—a section which will be of particular interest, as the methods are manifold and widely scattered in the literature.

A considerable portion of Part 1 is devoted to the consideration of general reaction kinetics. This subject has received so much publicity that the newer material is at last finding its way into text-books and thus its reproduction here is not so necessary. On the other hand, it makes the volume complete in itself. Thereafter follows the theory of polymer reactions. Its particular form follows closely the presentation which has been adopted by Prof. Mark and his collaborators in previously published work. Here there are many controversial points, but since the assumptions made are often extremely difficult to check experimentally, there is no point in discussing the more detailed parts of the theory provided it is realized that modification in the near future is almost inevitable.

Reference is made in Part 1 to some of the experimental work on the kinetics of polymerization, but the main account of the behaviour of various types of monomer is reserved for Part 2, in which each individual reaction is considered separately and all the relevant facts brought to notice. While this is invaluable as a compilation, it is disappointing to anyone primarily interested in discovering just how far kinetic analysis may be pushed in the examination of these reactions. Many of the reactions have, of course, not been studied in such a way that the data are suitable for analysis, and therefore strictly should be excluded. On the other hand, this lack of knowledge serves to emphasize where further work is needed and what reactions are most likely to be amenable to kinetic discipline.

This volume is, in short, a survey of the beginnings of a new subject and is in no sense a description of a rigorously developed theory supported adequately by exact measurements. It must therefore be read in this spirit. Prof. Mark and Dr. Raff may be congratulated on having the courage to attempt to bring coherence into a fresh region of reaction kinetics.

H. W. MELVILLE.

SCIENCE AND INTERNATIONAL POLITICS*

By SIR RICHARD GREGORY, Bart, F.R.S.

It was with a certain amount of reluctance that I accepted the invitation to address the Royal Institute of International Affairs upon the subject of "Science and International Politics". My hesitation was largely due to views expressed in the public press and elsewhere, after the recent Conference in London on Science and World Order, as to the desirability or otherwise of keeping science and politics within the particular fields of action commonly assigned to them. The Conference was organized by the Division for the Social and International Relations of Science of the British Association.

As science is an international study, the intention of the organizers of the Conference was to have the subjects of the programme presented from a world point of view. So far as I know, this was the first occasion on which many leading representatives of science, politics, and sociology, from many different countries, assembled with the common object of understanding each other's attitudes towards the subjects brought forward. It is not surprising that relationships of science to systems of government and to social problems attracted great public attention to the Conference, and that there were differences of opinion as to the value to the community of close or loose contacts between them. In countries where all the forces of science belong to a State service, the pursuit of knowledge for its own sake is not an organic part of the scheme of action, however much satisfaction it may give to individuals who undertake it, or however valuable the discoveries made may prove ultimately to be. Where science is regimented, no distinction is made between academic and applied scientists, and operations are assigned to each in the plan of campaign. Team-work is organized in the service of the State instead of being left to sporadic initiative.

This system of State planning of the pursuit of scientific knowledge with practical purpose as the aim is responsible for the great advances in science and industry achieved in the U.S.S.R. in recent years; and it has supporters among men of science in Great Britain. The basis of the system is obviously communistic; and British men of science who approve of it are regarded as both scientific and political revolutionaries whose activities are a danger to scientific freedom. Liberty of thought, work and expression is highly cherished in the commonwealth of science, and in Great Britain no conditions which would limit it would be tolerated. As citizens, men of science have the right to hold any political or religious faith, and the duty also of justifying it when needed. The general view is, however, that they should not embarrass science by advocating doctrines which would make her the handmaid of a particular political party.

This view was expressed by Sir Henry Dale in his presidential address delivered at the recent anniversary meeting of the Royal Society. "I see danger", he said, "if the name of science, or the very cause of its freedom, should become involved as a battle cry in a campaign on behalf of any political system, whether its opponents would describe it as revolutionary or reactionary. If science were allowed thus to be used as a weapon of political pressure, it would be impossible to protect science itself from the pressure of sectional politics".

Sir Henry Dale's remarks led to correspondence in *The Times* on science and politics and the organization of research in the social sciences. No one suggested that an authority in a particular branch of natural science could be assumed to have expert knowledge and experience in the fields of the political and social sciences. On the other hand, it was acknowledged that these departments of civil life could with advantage make fuller and more systematic use of scientific methods of inquiry into the factors which determine human conditions and potentialities to-day.

By modern use, science has come to signify natural philosophy, or verifiable knowledge acquired by observation and experiment. When its field of work is thus defined, there is an impermeable membrane between science and politics. The partition is dissolved when science—the domain of reason—is defined as systematic and formulated knowledge in all fields of human understanding—natural, moral, social and political. At all stages of civilization, these factors have determined the conditions of human life in varying degrees; and in modern times scientific knowledge has been the chief element in the constitution of man's outlook and the greatest power for social and political action.

As science, using the word in the sense now generally understood, is kept apart from politics, it has little influence upon the uses to which its power is applied, whether for good or evil. In general, this influence is not given effective attention in political and social philosophies; and the attitude towards it to-day is much the same as that of Plato towards the results of observational and practical inquiry represented by the Ionian school, upon the principles of which physical science may be said to be founded. In Platonic politics, the State decided what was good for the peoples to know and accept, and the purpose of legislation was to ensure the stability of a society of rulers and slaves. The spirit of political Platonism still prevails, even though modern science and technology have placed a score of mechanical slaves at the disposal of every citizen in a modern State.

In the understanding of this increased power, and in action based upon it, political leaders can scarcely be said to take adequate account of the changing conditions of life due to applications of new scientific knowledge, either in the present or for the future. They are in charge of the forces of science, and upon them is the responsibility of seeing that these are used effectively for the progressive welfare of the community. In this relation to politics, the functions of science may be compared with those of an intelligence department which possesses knowledge of the equipment available everywhere for social or political development, but has no influence upon action derivable from it.

In a democratic State, the uses made of science, like those provided for defence or attack on land, sea and air, are decided by leaders elected by representatives of the people. If these representatives rarely include men distinguished for their contributions to useful knowledge, it is because such original investigators find the air of the research laboratory more congenial and productive than the turbulent atmosphere of politics. In the discussion of any subject, the value of the views expressed depends upon the first-hand knowledge possessed of it. This is as true of politics as it is of science, though in

*Substance of an address delivered at the Royal Institute of International Affairs on Feb. 3.

these two fields rhetoric and fact differ in their influence.

As the forces of science are in action along the whole front of advancing civilization, it is essential that their strength and disposition should be given full consideration in all social and political campaigns. Their leaders have a right, and a responsibility to their colleagues as well as to other fellow-citizens, to share in the preparation of schemes of operation in which their forces are used. When they enter the field of politics, they possess at least as much general knowledge of the problems involved as is required of representatives of other interests, whether industrial, commercial and financial, or of the armed forces. Their views can have no special authority outside the scientific field to which they have devoted particular attention; but they may justly claim to have been trained to face facts before arriving at judgments, and the value of their public service depends upon their competence to transfer this faculty to the consideration of social and political problems.

One reason why few men of science care to take an active part in politics, is that they do not feel able to effect such a transfer of their trained habits of thought. Birth, social surroundings, and feeling largely determine the side taken in national politics, but all these have little to do with the making of scientific students and discoverers. It is only by applying to political problems the principles of independent inquiry and impartial judgment demanded of investigators in all branches of natural knowledge, that politics can become a science and scientific workers as such can contribute to its advancement. Without this spirit and purpose science and politics are best placed in separate categories.

There is, however, a vast difference between party politics of a national kind and international politics in which the world is the unit and all men are citizens of it, having rights and duties to be wisely adjusted with the object of ensuring progressive development everywhere. This is the field into which the international spirit of science can enter without being regarded as an intruder or becoming involved in controversial national politics. The world is the possession of man, and his endeavour should be to see that its resources, with the powers provided by science, are used for effective development. National boundaries have little relationship to the distribution of natural resources, and less to the needs of modern life. All communities can share in the achievements of scientific discovery and invention, and none can establish an exclusive right to the use of them. Radio communication and aviation have made it impossible for any one nation, or group of nations, to isolate itself from the others, whether near or far. There will be no need for any civilized community to strive for self-sufficiency in a single region, or within a political sphere of influence, when these world powers become agents of international politics. The way may be far to go before national interests will acquire an international outlook, yet the tendency of political groups to become larger gives promise of further expansion into a commonwealth of the chief free peoples of the world.

Such a commonwealth can be secured only by consent, and in it there will be no place for the mastery by force of one race or nation over another. No new world order can have stability unless each nation is free to follow its own lines of cultural development, and does not seek to deprive others of the same liberty. There can be patriotism without arrogance and unity without aggressive imperialism. What is wanted now is not pride of power to make one nation submit to the will of another, and the exercise of it to secure mastery of the world, but pride in a union upon the strength and structure of which each nation depends for freedom and security.

It is only with such a co-operative alliance in mind that the services of science can be used to shape the course of international politics. Knowledge of natural objects and phenomena—their properties, occurrence and range—is not confined to political regions, either in extent or in the use of it. This knowledge is free to the world, and is the foundation upon which the structure of modern civilization is based. It is continually revealing new sources of supply of materials, and power to expand this structure as well as to adorn it. Applied science has provided the means of making the world's abundance available to all peoples. The world is, indeed, self-sufficient to supply the needs of all mankind, and the aim of international politics should be to see that the supply is adjusted according to the need for the use of it.

In the fourth clause of the Atlantic Charter, Mr. Roosevelt and Mr. Churchill expressed the intention of the United States and the British Commonwealth to adopt this principle in a unified political policy. The clause declares that "they will endeavour, with due respect for their existing obligations, to further enjoyment by all States, great or small, victor or vanquished, of access, on equal terms, to the trade and to the raw materials of the world which are needed for their economic prosperity."

This Anglo-American declaration, with the power of two great democracies to implement it, gives an impressive outlook to a new world order. No federation of European States alone could make such a declaration of the effective value represented by the unification of purpose of the British and American Commonwealths. When the principle of freedom of access to the raw materials of the world is conceded by the chief nations of the world, the problems of international politics will be greatly simplified and science will become the chief factor in their solution.

What exists in the world, and what uses can be made of it, are discovered by scientific inquiry and its application. What action is taken upon the knowledge or power thus gained depends upon communities and their governments. Knowledge of natural forces and resources gives no control over them but only an understanding of cause and effect available for human service. Science as such is concerned with the advancement of natural knowledge, and its standards of value are neither ethical nor political. Men of science, therefore, make no special claim to express opinions upon political matters, except in so far as their pursuits affect the welfare of the community, and its repercussions with them. When, however, they give close attention to subjects outside the particular fields they have made their own, their reactions are at least as worthy of consideration as those of other enfranchised citizens.

The view that the sole function of men of science is to study and discover natural facts and principles without regard to the social implications of the knowledge gained can no longer be maintained. It is now widely acknowledged that science cannot be divorced from ethics or rightly absolve itself from the human responsibilities in the use of its powers in economic or political planning. Men of science neglect their duty if they continue to retain the monasterial habits which society commonly assigns to them, and are content to remain isolated from the structure of civilization built up from materials provided by them. It is their obligation as citizens to assist in the establishment of a rational and harmonious social order out of the welter of human conflict into which the world has been thrown because the powers they have released have not been rightly used in the services of mankind as a whole.

To suggest that the world is a single unit in which all men have certain fundamental rights to live and work, each according to his capacity and needs, may not be practical politics—national or international—yet these are the basic factors in the world's equation. Science and ethics should be able to agree as to the rights of all men to a place on this earth of ours and their duties to the community. Until international politics mean something more than a survey of national claims and actions, with no scientific or ethical principles upon which to arbitrate, expediency and not equity must continue to determine its judgments.

Before any worthy world order can be established, the fundamental rights of men and communities must be defined and acknowledged by the democracies which promote it. The Anglo-American Charter represents the beginning of the infusion of this spirit into the working of world affairs. The outlook of international politics is vastly extended by this Charter, and an instrument has been constructed which gives new meanings to the dimensions of time and space on a changing world. It recognizes by implication that the goal of a world commonwealth can be brought into sight and gives hope that the promise of a dream is not beyond fulfilment.

It was in this spirit that a Declaration of the Rights of Man was drafted a year ago by a committee under the chairmanship of Lord Sankey and submitted to public discussion. The opening paragraphs of the introduction to the Declaration may be appropriately reproduced here because they state world conditions differing from those with which international politics have hitherto had to deal. The paragraphs read as follows :

"Within the space of little more than a hundred years there has been a complete revolution in the material conditions of human life. Invention and discovery have so changed the pace and nature of communications round and about the earth that the distances which formerly kept the States and nations of mankind apart have now been practically abolished. At the same time there has been so gigantic an increase of mechanical power, and such a release of human energy, that men's ability either to co-operate with or to injure and oppress one another, and to consume, develop or waste the bounty of Nature has been exaggerated beyond all comparison with former times. This process of change has mounted swiftly and steadily in the past third of a century, and is now approaching a climax.

"It becomes imperative to adjust man's life and institutions to the increasing dangers and opportunities of these new circumstances. He is being forced to organize co-operation among the medley of separate sovereign States which has hitherto served his political ends. At the same time, he finds it necessary to rescue his economic life from devastation by the immensely enhanced growth of profit-seeking business and finance. Political, economic and social collectivisation is being forced upon him. He responds to these new conditions blindly and with a great wastage of happiness and well-being."

The object of the Declaration was to assemble and proclaim fundamental and inalienable rights of man as a species living upon the planet Earth, and with powers of conquest over agencies—natural or social—which obstruct his advancement. Science and the humanities can meet on common ground in an endeavour to make a charter of this kind represent elements which enter into human reactions and should be regarded almost as commandments for the guidance of international policies. When agreement has been reached upon the essential human needs and rights declared in such a charter, a very promising nucleus will have been created upon which scientific and ethical principles can crystallize. Without a foundation of this kind, conciliation of conflicting interests and political expediency will determine the influence and actions of leagues, unions, councils and courts, and there will be no fixed star by which to shape the courses of ships in the stormy seas of international politics.

Since the outbreak of the conflict in which all peoples of the world are now directly or indirectly involved, many declarations have been made of principles expressing the needs and aims of all men. They all have much in common, and from them it should be possible to construct fixed standards in which the rights of nations are given world values and the welfare of the whole community of mankind is the concern of international politics. However far distant we may be from the effective application of such basic principles, conditions of life to-day demand the formulation, by common consent, of a charter in which all communities will have world rights, relationships and responsibilities. There can be no unified political, economic and social order unless schemes of reconstruction are conceived in this spirit, with full knowledge of the primitive instincts of man and the lag between them and the powers which science have given him.

The three chief principles of inter-State intercourse, on which international law is based, are said with authority to be :

(1) Recognition of each other's existence and integrity as States.

(2) Recognition of each other's independence.

(3) Recognition of equality, one with another, of all independent States.

International law may narrate these principles, but international politics have made a mockery of them. A bewildered world finds itself deprived of all these 'recognitions', and seeks new fundamental truths to satisfy its outlook. The so-called laws of Nature are only generalizations which have to be revised when cases not covered by them are brought before the court of science. International politics has to adopt a similar attitude towards the evidence presented to it, and international statutes should not be limited to the relationships of one sovereign State to another, but of every State to all others.

In the realm of the humanities, as in that of the natural sciences, the closer the approach of a principle to fundamental truth, the longer will it survive. All peoples of the world have certain attributes in common, and all high religions teach the observance of certain ethical principles. When these principles have been analysed and collated, a sound basis will be secured for the constitution and judgments of a court of international politics, and the goal of world unity will come into view. Science can usefully combine with politics to attain this end.

GROWTH AND DETERMINATION IN THE DEVELOPMENT OF DROSOPHILA

By Dr. C. H. WADDINGTON
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IT is usually held that development in the Diptera is typically 'mosaic'. The determination of larval characters is known to take place at a very early stage (reviewed, Richards and Miller[1]), and that of the imaginal characters is not supposed to be delayed more than a few hours after fertilization. The evidence on which the latter part of this statement is based is not extensive. Geigy[2] observed the development of defects in Drosophila flies which had been injured by ultra-violet puncture shortly after fertilization, and Howland and Child[3] obtained similar results with mechanical injuries. Pursuing another line of experimental analysis, the workers with the transplantation technique of Beadle and Ephrussi have shown that the imaginal buds of the eye region, isolated from young larvæ, are able to develop well-formed ommatidia when isolated in the body cavity of host animals. Steinberg[4] has pushed back the earliest time from which successful development is possible to twenty-four hours after hatching, before which the buds are too small to be handled.

The history of the analysis of amphibian development is a warning of the danger of considering such defect or isolation experiments as satisfactory means of discovering the developmental potentialities of tissues; many cases are known in which, although defects are not made good, or 'self-differentiation' occurs after isolation, the tissues have later been shown to be still labile and capable of being deflected into quite a different developmental path. Some recent work on Drosophila indicates that a similar error of interpretation has been made in respect of the imaginal buds of that form.

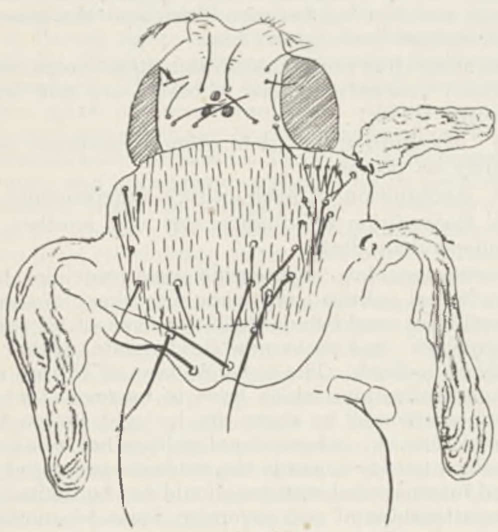

Fig. 1.
DROSOPHILA ADULT, X-RAYED AS LARVA AGED 66-72 HOURS AFTER LAYING. NOTE REDUPLICATION OF WING-BEARING REGION OF THORAX ON RIGHT SIDE.

Drosophila larvæ were treated with heavy doses (7,000 r-units) of X-rays. Pupæ aged more than twenty-four hours after puparium formation when irradiated showed little or no morphological effects. Irradiation in the period between twelve hours before and eighteen hours after puparium formation caused the death of large numbers of individual cells. This led to the cessation of morphogenesis in the wings at an early stage, but its most marked effects were on the chætal elements. Large numbers of bristles, both macro- and micro-chætæ, were removed; the macro-chætæ were more strongly affected towards the beginning of the period and the micro-chætæ towards the end. In Drosophila each bristle is accompanied by a socket, the complete apparatus being formed from a group of two cells. The proportion of cases in which both cells were removed was much greater than would be expected if the only effects were the direct results of ionizations; one must conclude that the two cells influence one another during development, and that the death of one is likely to prevent the differentiation of the other.

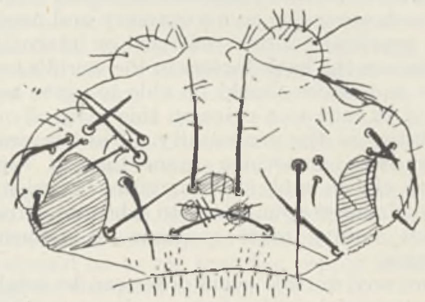

Fig. 2.
X-RAYED AS 72-90 HOUR LARVA. NOTE PALPS ON BOTH EYES.

The most interesting results were obtained with irradiations of larvæ aged 60–90 hours after laying, that is, in the early part of the third instar. The mortality was very high, and no flies succeeded in emerging from the pupa cases; those which did develop had to be freed from their pupal integuments by dissection. In most of them, various organs were found to be hypertrophied; and the increases in size of the parts were often accompanied either by reduplication or by the development of tissue characteristic of some other part of the body. The antennæ were little affected, although in one case the base of the arista was transformed into a somewhat leg-like material. The eyes, on the other hand, were very frequently abnormal; they were usually larger than normal, and the anterior dorsal region was transformed into a palp bearing typical bristles, and this might be lengthened into a band cutting the whole eye into two parts, which should probably be regarded as two separate eyes developed by reduplication. In a few cases the palp had the character of an antenna. Overgrowth in the thorax led either to duplication of some regions (for example, the scutellum or the wing-bearing region) or merely to the formation of an irregular and lumpy thorax. Within the wing itself, extra lobes might be formed, or part of the wing might be converted into a tissue resembling the normal body surface. The legs were highly abnormal, often sharply bent and very swollen.

Larvæ much younger than sixty hours at irradiation gave rise to completely normal adults. We therefore find that the developmental fate of imaginal buds can be changed as late as ninety hours after laying, while earlier than sixty hours determination is so indefinite that complete regulation is still possible. The agent by which these changes have been produced (7,000 r-units of X-rays) is, of course, a drastic one, but the effects produced cannot be considered to be merely injuries (for example, the

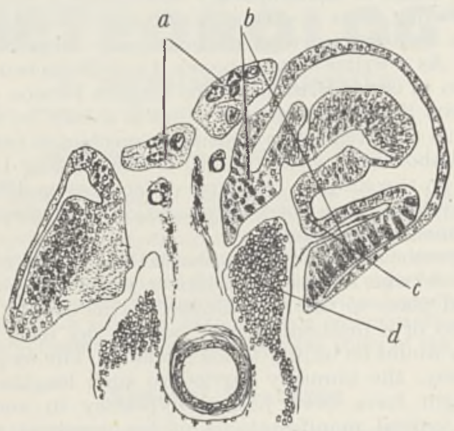

Fig. 3.

SECTION THROUGH IMAGINAL BUD OF RIGHT EYE IN LARVA X-RAYED WHEN AGED 72–90 HOURS. *a*, WEISSMAN'S RING; *b*, EYE-FORMING REGION OF IMAGINAL BUD; *c*, FOLD IN BUD, WHICH WILL GIVE RISE TO PALP; *d*, ANTERIOR PART OF BRAIN.

conversion of eye material into antenna). We must conclude that changes in developmental fate can be caused by factors which can be produced, under the influence of X-rays, by the tissues themselves. It becomes then a reasonable hypothesis to suppose that determination in normal development is brought about by similar tissue interactions; and one is inevitably reminded of the organizer phenomena in vertebrate embryology.

The nature of the determining factors produced by the irradiation cannot be stated with certainty, but it is clear that changes in growth are intimately involved with them. This is so not only in the cases where an obvious hypertrophy has occurred as in the reduplicated organs, but also in connexion with the palp-formation in the eyes. In the cephalic imaginal buds of irradiated larvæ just before pupation a fold can often be found in the eye-forming region, and it seems certain that this is (*a*) a result of an overgrowth of this region, and (*b*) the forerunner of a palp. An exactly similar appearance can be found in the imaginal buds of larvæ homozygous for the gene *ophthalmopedia* (stocks of which I owe to the kindness of Dr. C. Gordon), which causes the formation of eye-palps very similar to those in the irradiated flies.

There is evidence from another quarter which strongly suggests that abnormalities of growth, by causing irregularities of the folding of the imaginal tissue, eventually bring about changes in differentiation. Several genes are known which affect the legs of Drosophila; *dachs* and *fourjointed* shorten the legs and reduce the number of tarsal joints to four, *dachsous* produces somewhat irregular short legs, and *comb-gap* (derived from an *S E-S/cg l* stock obtained from Muller; possibly two closely linked genes are concerned in the variable effects noted here) causes the legs to be irregularly swollen, sometimes very considerably. All these genes have secondary effects; that of *comb-gap* is the production of a gap in the fourth longitudinal vein on the wings, but in the others the effects clearly involve growth, the wings being reduced in size and made rounder, the thorax made short and thick, etc. The leg effects, which are the most easily recognized, can easily be detected in the imaginal buds at the time of pupation. None of the genes produces any changes in tissue differentiation when alone, nor do most of the compounds; homozygous *dachs-fourjointed* look the same as *dachs*, while in *dachsous-combgap* the leg buds are highly abnormal and frequently, owing to faulty eversion and failure of the subsequent contraction, produce legs more like flippers than normal Dipteran limbs. But very different phenotypes are produced by *dachs-dachsous* or *fourjointed-combgap*. In both cases reduplications and changes in differentiation are quite frequent; the antennæ are often double, and parts of the eye may be converted to antennæ (five antennæ on one head is the maximum number so far recorded), the blade of the wing may have extra lobes, or be duplicated in part, the whole wing region may be converted into typical body-surface, the legs may terminate in arista-like tufts, etc. In the case of the eye, abnormal folding, presumably the forerunner of antenna-formation, has been detected in the imaginal bud.

We have then two cases of two genes, each of which affects the growth of many parts of the fly, producing when in combination effects not only on growth but also on the type of differentiation undergone by the various imaginal buds. It is scarcely plausible to suggest that several different morphogenetic substances are involved, and that the genes when in combination, but not when alone, affect all these substances by some mechanism other than through their growth-effects. After accepting the evidence of the irradiation experiments that Drosophila imaginal buds remain incompletely determined throughout the greater part of larval life, much the simplest hypothesis is to suppose that their determination can be affected by abnormal folding, which can be produced by irregularities in growth.

Fig. 4.

HEAD OF ADULT OF GENOTYPE *cg c fj px sp* (THAT IS, *combgap-fourjointed*). NOTE CONVERSION OF EYE TO ANTENNA, AND SWELLING OF THORAX.

[1] Richards, A. G., and Miller, A., *J. N.Y. Entom. Soc.*, **45**, 1 (1937).
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OBITUARIES

Prof. T. Levi-Civita, For. Mem. R.S.

TULLIO LEVI-CIVITA was born at Padua on March 29, 1873, son of a renowned advocate who was mayor of Padua and senator of the realm. He entered the University of his native city where, after studying with Veronese and Ricci, he graduated in 1894; four years later he was appointed to the professorship of mechanics at Padua. In 1914, he married Sig.na Libera Trevisani, one of his former students. In 1918, he was called to the University of Rome, where he occupied the chair of theoretical mechanics until his dismissal, in 1938. He died in Rome, after a lingering illness, on December 29.

Levi-Civita was unquestionably one of the best-equipped and most versatile mathematicians of our time: primarily an applied mathematician, he had been strengthened by the magnificent discipline of the Italian geometrical school which, apart from inspiring his valuable researches in differential geometry proper, furnished him with powerful weapons for attacking the problems of physical science. In the latter field his interests were all-embracing, and he made important contributions to such diverse topics as potential theory, wave motion, hydrodynamics, analytical dynamics, relativity theory, thermodynamics and theoretical physics, in particular, quantum mechanics. On the more technical side, where he was often called into consultation by his colleagues, he studied various complex problems in electrodynamics, elasticity and strength of materials, devising practical methods of calculation which have since proved their worth.

In the field of pure mathematics his interest was scarcely less extended. One may mention that his first papers were on the distribution of prime numbers and the foundations of geometry; afterwards, as a natural outcome of his other work, he was drawn to the study of conformal representation—in which, as regards its applications, he was one of the pioneers —and the theory of partial differential equations. He also made one of the earliest contributions to the theory of functions of two complex variables: all this, be it observed, in addition to the work in differential geometry for which he is chiefly celebrated.

At this point it is interesting to recall that Levi-Civita's teacher, Ricci, was once refused a Royal Prize for his work on tensor calculus, on the ground that it could not conceivably be of use to anyone, even a differential geometer. An apt comment on this verdict was later to be provided by Einstein's general theory of relativity, the foundations of which were actually laid in a great memoir by Ricci and Levi-Civita themselves. However, both before and after the tensor calculus had become useful, Levi-Civita was its most assiduous cultivator; and during a long period the *Rendiconti* of the Lincei were enriched by a series of notes on differential geometry, treated by its methods. These researches culminated in the memoir of 1917, introducing the concept of parallelism with which his name is associated, and constituting perhaps his surest title to fame.

The fecundity of such a great and varied production is amply proved by the number of disciples who have followed in its wake and the schools which have found inspiration in its conceptions. This multiform activity was centred, not in the published work, but directly in its creator. For more than forty years Levi-Civita was one of Italy's greatest teachers, drawing to himself students from all over the world, aiding and encouraging them with inexhaustible patience and generosity. Part cause, part effect of these contacts was a knowledge of mathematical literature that was truly encyclopædic; until the end Levi-Civita maintained his grasp of nearly the entire range of contemporary mathematics, and with his reading went a vast scientific correspondence, to which he attended with his customary diligence and zeal. As a writer of text-books, Levi-Civita is mainly known in Great Britain by the English version of his work on the tensor calculus; but it should be added that his comprehensive treatise on mechanics (written in collaboration with Amaldi) is the leading Italian work on the subject. A course of lectures on differential systems and wave propagation has also been published in book form.

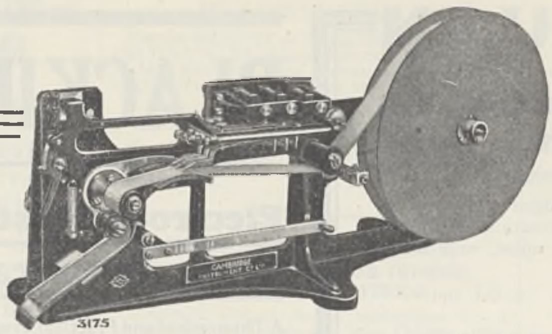
Nevertheless, however splendid his achievement, to those who have known him it must always take second place to the man himself. This cannot often be said of a mathematician; not to say it of Levi-Civita would be unjust to his memory. The exquisite courtesy, the humility carried to such lengths that it might have been judged hypocrisy in another, were typical manifestations of his generous spirit. Many will have received some special token of his kindness; many more will have enjoyed his hospitality, or carry with them the indelible souvenir of his presence in the lecture room: the characteristic figure on the rostrum expounding, with overwhelming enthusiasm, some point in the theory of mechanics or differential equations.

Levi-Civita was the recipient of many academic distinctions and honorary member of numerous societies, in particular, of almost all the scientific academies of Italy and Germany. In 1938, when dismissed from his post in consequence of the racial legislation, he was also expelled from the latter, with the sole exception of the Pontifical Academy of Sciences. In Italy itself his death occasioned no official response, save within the Vatican City, where, at a recent session of the Pontifical Academy, he was duly commemorated. His last years had been overcast by an ever-deepening pre-occupation with the future of his country; it is easy to imagine how so liberal a mind, coloured with the Garibaldian traditions of his early education, viewed the progressive decay of international relations and ethical standards. With his death there has passed away a man of science and an Italian whom we can ill afford to lose and whom we shall not soon see replaced.

L. ROTH.

Dr. A. K. Chalmers

WE regret to announce the death at the age of eighty-six of Dr. Archibald Kerr Chalmers, one of the most eminent contemporary epidemiologists. He was born at Greenock in 1856, and received his medical education at Glasgow, to which he remained faithful, and qualified in 1879. After holding resident appointments at the Glasgow fever hospital, he was appointed medical officer of health for that city in 1892, and held the office until his retirement in 1925. Throughout his life he showed a remarkable administrative and literary activity. During his term of office he was busily engaged in the management of acute infectious diseases. Besides Chalmers's principal



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work entitled "Health of Glasgow, 1818–1925: An Outline" (1930), which may be regarded as a classic, he was also author of addresses on several sanitary subjects, such as "Vital Statistics of School Ages" (1898), "The House as a Contributory Factor in the Death-Rate" (1913), "Economy in Food during the War" (1915), and in 1924 delivered the Watsonian Lectures before the Faculty of the Royal College of Physicians and Surgeons of Glasgow on "Epidemic Diseases of the Central Nervous System".

Chalmers received many well-merited honours, such as those of honorary LL.D. of Glasgow, honorary fellowship of the Royal Faculty of Physicians and Surgeons of Glasgow and the Médaille du Roi Albert. He was president of the Section of Epidemiology and State Medicine of the Royal Society of Medicine in 1920.

J. D. ROLLESTON.

WE regret to announce the following deaths:

Sir Robert Chapman, C.M.G., professor of engineering in the University of Adelaide during 1907–37, president of the South Australian School of Mines, aged seventy-five.

Sir Robert Elliott-Cooper, formerly president of the Institution of Civil Engineers, on February 16, aged ninety-seven.

Prof. Max Kriss, associate professor of animal nutrition in Pennsylvania State College, aged fifty-two.

Dr. Paul S. McKibben, professor of anatomy and dean of the School of Medicine of the University of South California, known for researches on the nervous system of Amphibia, aged fifty-five.

The Very Rev. Sir George Adam Smith, F.B.A., Principal of the University of Aberdeen during 1909–35, on March 3, aged eighty-five.

NEWS and VIEWS

Prof. A. C. Hardy, F.R.S.

PROF. A. C. HARDY, whose appointment to the regius chair of natural history in the University of Aberdeen has just been announced, is well known for his distinguished work on plankton problems. The development of the strikingly new methods which he has evolved in this work may be traced to the time when, as a member of the scientific staff of the Ministry of Agriculture and Fisheries, he introduced a simple plankton recorder made to assist fishermen in the location of herring shoals. Later, as second-in-command on the scientific staff of the Discovery Committee, he spent some two years in the Antarctic in the R.R.S. *Discovery*, and here had opportunities for the invention of a much more elaborate instrument designed to give a continuous record of the plankton, while being towed at full speed. Undeterred by initial failures he finally perfected this instrument, and from the new department which he later founded at University College, Hull, he inaugurated comprehensive plankton surveys of the North Sea with plankton recorders used from commercial vessels. This work, with Government assistance, developed rapidly until the War made it necessary to discontinue operations at sea; a substation was opened at Leith and a number of very valuable reports have appeared in the *Hull Bulletins of Marine Ecology*.

It is satisfactory to learn that Prof. Hardy's fruitful work on the North Sea plankton will continue. On taking the chair at Aberdeen he will become honorary director of oceanographical investigations at University College, Hull, and the oceanographical work of that department will henceforth be in charge of Mr. C. E. Lucas, the senior member of his research staff. In addition to this profitable work on plankton, Prof. Hardy has most ingeniously adapted oceanographical methods to the study of insect distribution. Using devices similar to those employed under water, he has flown light nets, fitted with opening and closing mechanism, from kites; and in this way has shown that many species of insect, including agricultural pests, can be brought to Great Britain in the upper layers of the air.

Royal Society of Edinburgh

THE following have been elected ordinary fellows of the Royal Society of Edinburgh:

Prof. T. Alty, Department of Applied Physics, University, Glasgow; Mr. R. E. Cooper, curator, Royal Botanic Garden, Edinburgh; Dr. James Cossar, lecturer in technical mathematics, University, Edinburgh; Prof. T. Dalling, director, Ministry of Agriculture's Veterinary Laboratory, Weybridge; Dr. S. C. Das, lecturer in pharmacology, Robertson Medical School, Nagpur, C.P., India; Dr. Andrew Davidson, chief medical officer, Department of Health for Scotland; Mr. Arthur Earland, Edinburgh; Dr. G. H. Edington, Glasgow; Mr. A. H. Gosling, assistant commissioner, Forestry Commission, Scotland; Prof. A. Gray, Department of Political Economy and Mercantile Law, University, Edinburgh; Dr. R. A. R. Gresson, Department of Zoology, University, Edinburgh; Dr. K. E. Grew, lecturer in physics, Heriot-Watt College, Edinburgh; Dr. W. A. Harwood, superintendent, Meteorological Office, Edinburgh; Dr. J. R. M. Innes, pathologist, Biological Laboratories, I.C.I. (Dyestuffs) Ltd., Hexagon House, Manchester; Dr. Daniel Lamont, surgeon, Glasgow Royal Cancer Hospital, and Glasgow and West of Scotland Radium Institute; Dr. W. M. Levinthal, bacteriologist, Royal College of Physicians Laboratory, Edinburgh; Dr. James Macfarlane, medical liaison officer, Scottish Office, London; Mr. Peter N. McFarlane, Glenordie, Stanley, Perthshire; Dr. J. F. Malcolm, lecturer in bacteriology, West of Scotland Agricultural College, Glasgow; Prof. S. T. Mayow Newman, Reid School of Music, University, Edinburgh; Dr. Jocelyn Patterson, lecturer in biochemistry, Charing Cross Hospital Medical School; Dr. J. R. Peddie, secretary, Carnegie Trust for the Universities of Scotland; Mr. Douglas M. Reid, senior biology master, Harrow School; Prof. W. J. B. Riddell, Department of Ophthalmology, University, Glasgow; Dr. J. D. Robertson, Courtauld Institute of Biochemistry, Middlesex Hospital, London; Dr. William Scott, Fryern Hall, Bridgewater, Somerset; Mr. Charles Strachan, lecturer in applied mathematics, University, Liverpool; Dr. Joseph Tait, resident secretary in Scotland, Pharmaceutical Society; Mr. D. R. Wilson, bacteriologist, Moredun Institute, Animal Diseases Research Association, Gilmerton, Edinburgh.

The Council of the Royal Society of Edinburgh has awarded the Keith Prize for the period 1939–41 jointly to Prof. E. T. Copson, University College, Dundee, and to Prof. W. H. McCrea, Queen's University, Belfast, for their papers in the *Proceedings* of the Society within the period of the award, and in recognition of their valuable contributions to the theory of Riemannian space and general relativity.

The Neill Prize for the period 1939–41 has been awarded jointly to Dr. P. C. Koller, Institute of Animal Genetics, University of Edinburgh, for his contributions to cytology; and to Dr. W. J. McCallien, Department of Geology, University of Glasgow, for his contributions to the tectonic geology of the Scottish Highlands.

Philosophy of the Physical Sciences

IN his recent presidential address to the Royal Society of Edinburgh on "Some Disputed Questions in the Philosophy of the Physical Sciences", Prof. E. T. Whittaker discussed the problem raised by the Greeks and at the present time vigorously debated by Eddington, Jeffreys, Milne, Jeans, Dingle and others, on the respective shares of reason and observation in the discovery of the laws of Nature. He recalled that the Greeks considered that geometry could be built up completely apart from observation, but that Aristotle at least (and much later Aquinas) held that other sciences must be built on experience. Later progress showed that geometry also must be regarded as a branch of experimental knowledge, and from the time of Newton until now, the principle that science rests fundamentally on observation and experiment has been unchallenged. Now, however, certain thinkers—notably Milne and Eddington—hold that the laws of Nature can be derived without recourse to observation. Prof. Whittaker points out that many important branches of physics can be deduced from single "postulates of impotence"; for example, the whole of relativity theory follows from the postulate that it is impossible to detect absolute motion. Such postulates are not the direct result of experiment, though they are generalizations from experiment. Milne's "cosmological principle" is in form a postulate of impotence, but it is assumed without experimental support. Eddington's "epistemological principles", however, are different, but Prof. Whittaker is not convinced that they have any basis outside experience. His verdict on Eddington's claim is: "Not Proven".

The concentration into postulates of impotence of the experimental contribution to physical laws is a very suggestive generalization, and it is an interesting conjecture that the whole of physical law might ultimately be derived by reason from a single postulate of impotence. At the same time it would be a mistake to suppose that anything significant can come out of a pure negation. A postulate of impotence is indebted to experience not only for failure to violate it but also for an indication of the positive thing which in the stated circumstances it denies. The impossibility of spontaneous passage of heat from cold to hot bodies implies the fact of experience that heat can pass between bodies; the denial of absolute motion would be without meaning if we had no experience of relative motion; and so on. It is a pity that Prof. Whittaker's address was prepared before Eddington's recent change of front. In the "Philosophy of Physical Science" he wrote: "For the truth of the conclusions of physical science, observation is the supreme Court of Appeal" (p. 9), and accepted the statement that physics is "the rational correlation of experience" (p. 185). In NATURE of October 25, 1941, however, he stated, in reply to the objection that the supreme Court of Appeal might decide against the rationally derived laws, that "the fundamental ('inviolable') laws are not assertions about experience". It appears, therefore that Prof. Whittaker has been analysing a superseded claim.

Science as a Force of Freedom

THE value of science as a force of freedom was emphasized by Mr. G. B. Lal in a recent address to the New History Society, New York. The power of science is unique. Great men of science have world-wide influence. But they have achieved such influence without the use of the slightest violence or fraud. People have killed each other for religion; but not for science. In science there is a peculiar and most important pattern of freedom. Science develops only when the scientific worker has enough social power to enable him to do his work utterly unhampered. Also, every development in science releases new forms of social energy. Most people respect science because of its practical importance, as shown by the machines of scientific inventors, the conquest of diseases, the piling up of profits in industries, the production of military weapons, rapid transportation and communication. But the most important thing about science is its method. The scientific method is the most efficient use of human intelligence for the discovery of truth.

Physics of a Transmission Line

PROF. W. M. THORNTON has published a thought-provoking paper with the above title (*J. Inst. Elec. Eng.*, 88, Pt. II, No. 6, Dec., 1941) in which he deals with the fundamental and, in part, unknown field of electromagnetic study underlying the many technical and economic problems entailed in the design, construction and operation of electric transmission lines. He pays special attention to the electromagnetic mechanism by which electric and magnetic stresses in space combine so that the energy of electric strain passes continuously along the insulating medium around the wires. Remarking that this, the Poynting flux flow, is the least known of the physical actions in transmission, Prof. Thornton discusses the transfer of potential energy along a transmission line by strain of the insulation, extending the theory to the supply of energy to electric lamps, heaters and rotating machinery. Following a lucid explanation of Poynting's theorem, physical analogies are given to the resistance, inductance and capacitance of a transmission line, resistance being regarded as the coefficient of dissipation of energy, inductance as inertia, and capacitance as elasticity; an invisible shaft of energy which would be perfectly rigid in the absence of inductance and capacitance rotates about the conductors of a three-phase system at the supply frequency.

Suggesting that there may still be engineers who regard the purity of the copper of their machines or cables as more important than insulation quality, the paper proceeds to a discussion of the function of insulation and the complex nature of corona, pointing out the limiting influence of the latter on voltage, while emphasizing that from the same aspect moisture effects are more important than corona. Prof. Thornton closes with a brief mention of the mechanical design of insulators, remarking that the complex physical stresses, electrical and mechanical, in a suspension insulator form a difficult three-dimensional problem which may well repay further investigation.

Technical Developments in Broadcasting

IN his chairman's address to the Wireless Section of the Institution of Electrical Engineers (*J. Inst. Elec. Eng.*, 89, Pt. 1, No. 13; 1942) H. Bishop of the B.B.C., in reviewing the general trend of progress up to the outbreak of hostilities, gave first an outline of the underlying principles involved in the acoustic design of studios and mentioned some of the difficulties associated with the microphone. Programme input equipment and the control and measurement of the volume of broadcast programmes were discussed, special mention being made of the war-time application of sound recording and reproduction by the B.B.C. Tribute was paid to the Post Office in connexion with the use of telephone networks as music, control and television circuits. Transmitter design, modulation and frequency control and power plant received considerable attention. The influence of ionospheric storms on short-wave propagation was discussed, and a section included on the application and control of frequency measurement stations. The address closed with a reference to post-war receivers, suggesting that greater measures of standardization and reliability are needed to achieve the success so dependent on public interest.

Meteorology of Rhodesia

THE Meteorological Report of the Rhodesia Meteorological Service for the year ended June 30, 1940, has the signature of R. A. Jubb, acting chief meteorologist, owing to the appointment of the chief meteorologist, Mr. N. P. Sellick, to the post of deputy director of meteorological services of Southern Africa, with his headquarters at Pretoria. Since the period covered by the report includes the outbreak of war, to the normal activities of the service was added the work of reorganization to meet naval and military war-time requirements and the restrictions imposed by the censorship on the publication of weather reports and forecasts. In consequence of this handicap there are few new developments to record, but on the other hand the collection of meteorological statistics, including hourly readings of various instruments at the main observatories, was maintained without any general interruption, and continued to prove of great value to engineers and to various industrial enterprises. These statistics, in tabular form, occupy the greater part of the report. The addition of thermographs to many climatological stations was found to be useful both in tracing the travel of weather systems and as a check on the readings of thermometers. The seasonal forecast of the general rainfall by a formula taking into account the values of various meteorological elements at 'action centres' in distant regions was continued. A deficiency of 4·8 in. was predicted for 1939–40, but an excess of 3·3 in. was experienced. In the eleven years for which the results of such forecasts are available there were only two other comparable failures, whereas successful predictions were made in seven years, the most notable being an almost exact prediction of the outstandingly heavy rainfall of 1938–39, which amounted to an excess of 12·2 in. compared with the predicted excess of 11·8 in. The utility of these forecasts now appears to have been firmly established,

Social Implications of Dietetics

ADDRESSING the Rugby Branch of the Association of Scientific Workers on February 19 on the "Social Implications of Dietetics", Prof. V. H. Mottram examined the possibility of securing the basic dietetic essentials for healthy living in present circumstances. He stated that an investigation in Leicester as to the present cost of providing as close as possible an approximation to the British Medical Association estimate would be 11*s*. 3½*d*. per head per week. He compared with this the allowances being given for evacuated children and the dependants of Service men. Prof. Mottram suggested that only by special provision of family allowances on a fairly generous scale will it be possible to ensure that children will receive their needful intake of food essentials, and emphasized that the logic of free education leads on to the provision of free food for children and adolescents.

The future agricultural policy of Great Britain, Prof. Mottram said should be directed to growing more 'protective' foods—such as dairy foods and market garden produce—for which the soil and climate are best fitted. In this he was sustained by the agreement of Sir John Russell, Sir John Orr and Mr. A. G. Street. On the question of health in war-time, while pointing out that the tuberculosis-rate is rising, he agreed that there seems to be no deterioration and even some improvement in general health. This he attributed, not to any beneficial effects of rationing, but to better and more food being consumed by the millions now employed who have previously been unemployed, and by the millions now in the Army who are better fed than before. His conclusion was that little can be done in war-time to improve diet, though the provision of concentrates might be helpful.

Banana Research in Trinidad

PROF. C. W. WARDLAW, Barker professor of cryptogamic botany in the University of Manchester, read a paper on banana research in the Imperial College of Tropical Agriculture, Trinidad, at the Royal Society of Arts on February 24. After emphasizing the merits of the Jamaica banana or Gros Michel as a commercial variety, Prof. Wardlaw discussed its susceptibility to Panama disease, caused by the soil-borne fungus *Fusarium oxysporum cubense*. A three-fold research scheme to deal with this was organized by the College in collaboration with the Royal Botanic Gardens, Kew. Prof. Wardlaw then indicated some of the practical and scientific results obtained from this research scheme. Hybridization experiments and storage investigations were also described. Prof. Wardlaw was closely associated with these researches while on the staff of the Imperial College of Tropical Agriculture. Readers will recall the excellent series of three articles by him on the banana in Central America in NATURE (147, 313, 344, 380; 1941); and now they are recommended to read the present address, which covers the whole field and which will be published in due course in the *Journal of the Royal Society of Arts.*

Menace of Typhus

ACCORDING to an editorial in the *Medical Officer* of February 21, the prospect of typhus reaching Great Britain is more than likely, but the spread of the disease can be as certainly checked by extermination of lice as smallpox can be by vaccination. The distribution of typhus at the present time is mainly confined to Spain, North Africa and Eastern Europe. In October and November 1941 less than twenty cases a week were noted in the civil population of Germany. On the other hand, the article states that if the Russian counter-offensive becomes a rout and Germany is invaded, it would be impossible to prevent the disease spreading to the civil population of Germany and to all the occupied countries in Europe. Unless, however, the Germans invade Britain *en masse*, this country is not likely to be over-run by typhus. No case of typhus in Great Britain has been recorded for more than ten years, and there have been only rare and small outbreaks for the past half-century, in contrast with Ireland where there is an endemic focus in Connaught. The unlikelihood of the disease gaining a foothold in Great Britain is increased by the uncertainty of the head louse conveying the disease, the comparative rarity of body lice in our population and the comparative facility of body delousing.

University Grants

SIR KINGSLEY WOOD has announced in a written reply to a question in the House of Commons that the Government is to maintain its grant for 1942 to the universities at its existing level. He recalled that, in view of the vital part played by the universities in the life of the community, the importance of maintaining so far as possible standards of university education and the essential contribution of the universities towards the national effort, the Government decided early in 1941 to keep the universities grant at the 1939 and 1940 figure, namely, £2,149,000. The impact of the war on university finance has so far been less severe than was expected. On the other hand, while the repair of physical damage resulting from enemy action can be dealt with under the existing war damage legislation, the repair of war damage is by no means the only problem, involving large demands on university funds, which will arise on the conclusion of hostilities. In reaching a decision, the Government had in mind these points, and had also considered a report from the University Grants Committee reviewing the whole situation.

University of London

THE degree of D.Sc. has been conferred on the following: Dr. G. W. Scott Blair (National Institute for Research in Dairying); Dr. A. H. Cook (Imperial College of Science and Technology); Mr. C. L. Hewett (Royal Cancer Hospital (Free) and the Sir John Cass Technical Institute); Mr. Alexander King (Imperial College of Science and Technology); Mr. M. A. Phillips (Battersea Polytechnic); Dr. Eugene Rothstein (Imperial College of Science and Technology); Dr. Frank Smithson (Birkbeck College); Prof. F. R. Winton (University professor of pharmacology in University College).

The William Julius Mickle Fellowship has been awarded to Prof. Alexander Fleming, professor of bacteriology in St. Mary's Hospital Medical School.

Regulations have been adopted for the recently instituted certificate of proficiency in radio-physics.

Scholarships in Electrical Engineering

APPLICATIONS, which must be received not later than April 15, are invited for the following scholarships awarded by the Institution of Electrical Engineers (Savoy Place, London, W.C.2): *Duddell Scholarship* (value £150 per annum, tenable for three years): Open to British subjects under nineteen years of age on July 1, 1942, who have passed the matriculation examination of a British university or an examination exempting from matriculation and who wish to take up a whole-time day course in electrical engineering; *Silvanus Thompson Scholarship* (value £100 per annum and tuition fees, tenable for two years, renewable in approved cases for a third year): For works employees who are the sons of parents of limited means. Open to British subjects under twenty-two years of age on July 1, 1942, who (*a*) have served a minimum apprenticeship (or its equivalent) of three years at an approved electrical engineering works, and (*b*) in addition to having taken full advantage of available opportunities for technical education, have acquired a marked degree of skill, and/or shown evidence of originality. The successful candidate will be required to take up a whole-time day course in electrical engineering at an approved university or technical college; *William Beedie Esson Scholarship* (value £120 per annum, tenable for two years, renewable in approved cases for a third year): For works employees who are the sons of parents of limited means. Open to British subjects under twenty-two years of age on July 1, 1942, who have served a minimum apprenticeship (or its equivalent) of three years at an approved electrical engineering works. The successful candidate will be required to take up a whole-time day course in electrical engineering at an approved university or technical college.

Announcements

THE Medical Research Council has appointed Prof. A. W. M. Ellis, formerly University professor of medicine at the London Hospital, to a whole-time position on its scientific staff as director of research in industrial medicine. The investigations to be undertaken by Prof. Ellis and his assistants will in the first instance be directed to problems of industrial toxicology which are of special importance during the War.

FOR the second year, the Rockefeller Foundation has made a grant to enable the Royal Society to assist scientific societies and associations to meet the financial difficulties involved in the publication at the present time of scientific journals. This generosity, which last year benefited a number of bodies, will be widely appreciated.

THE Royal Society of Arts has awarded the annual Thomas Gray Memorial Trust Prize of £50, for an invention advancing the science or practice of navigation, to Mr. T. E. Metcalfe, of Windsor, for the seaman's protective suit devised by him. This suit, which, when not in use, folds into a compact bundle, weighing about 3 lb., forms a complete covering of water- and wind-proof material to be put on when a shipwrecked person reaches a lifeboat or raft. It is being provided by the Ministry of War Transport on a wide scale, and has already saved many men from death by exposure to the elements.

LETTERS TO THE EDITORS

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

Ascorbic Acid in Oranges

IN 1934 Bacharach, Cook and Smith[1] reported that the concentration of ascorbic acid in the peel of oranges was greater than that in the juice. This was the result of tests carried out on five bitter oranges and one sweet orange, and was afterwards confirmed by various workers[2-6]. In connexion with an investigation on methods of preparing orange juices for drinking purposes we have taken the opportunity of repeating this work. Table 1 gives the results of the examination of eight South African oranges.

TABLE 1.

	Concentration of ascorbic acid		
	mgm./gm.		gm./lb.
	Range	Average	
Whole peel	1·01–2·27	1·52	
Pulp*	0·42–0·64	0·52	
Juice	0·42–0·62	0·51	
Whole orange	0·58–1·09	0·81	0·368

* The pulp consisted largely of the skin enclosing the segments of the fruit together with a little of the inner white skin.

Two methods of preparing orange drinks have been tested: (*a*) using the juice obtained by rotary squeezing and (*b*) using a process in which thin slices of whole orange are extracted by sugar syrup. Referring the ascorbic acid content to a unit weight of one pound of oranges, Table 2 shows the results obtained.

TABLE 2.

	Ascorbic acid	
	gm.	As percent. of whole orange
Whole orange	0·368	—
Juice obtained by method (*a*) Experiment I	0·114	31·0
,, ,, ,, ,, (*a*) ,, II	0·113	30·7
Extract ,, ,, ,, (*b*) ,, I	0·238	64·7
,, ,, ,, ,, (*b*) ,, II	0·238	64·7
,, ,, ,, ,, (*b*) ,, III	0·245	66·6

TABLE 3.

	Concentration in mgm./gm.		
	Ascorbic acid	Dehydro-ascorbic acid	Total ascorbic acid
Initial sample	2·11	0·16	2·27
Sample minced and allowed to stand for 3 hours	0·46	1·43	1·89
Sample minced and allowed to stand for 22 hours	0·14	0·05	0·19

If therefore it is desired to extract as much ascorbic acid as possible from oranges, method (*b*) is to be preferred, as there is made available by this means about 65 per cent of the total ascorbic acid in the whole orange as against 31 per cent obtained by using the juice alone.

The relative stability of the ascorbic acid in orange juice is generally recognized. It is therefore considered of interest to record one observation of the rapid disappearance of ascorbic acid in minced orange peel exposed to the air.

Similar results have been obtained by us with cabbage and are recorded in the literature for cabbage and other vegetables. We are inclined to the view that this disappearance of ascorbic acid may be ascribed to the action of an oxidase.

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[3] Giroud, Ratsimamanga, Leblond, Chalopin and Rabinowicz, *Soc. Chim. Biol.*, **18**, 573 (1936).

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Effect of Œstrin Injections on the Mouse Ovary

IN 1941 Bullough and Gibbs[1] showed that, both in the mouse (*Mus musculus* L.) and the starling (*Sturnus vulgaris* L.), maximum mitotic activity in the germinal epithelium of the ovary is confined to a short period immediately following ovulation, and it was suggested that, in all probability, some hormone, coming into full operation at this time, stimulates the epithelium to produce large numbers of new oogonia. It has since been shown[2] that a similar post-ovulation peak of mitotic activity is present in the ovary of the minnow (*Phoxinus lœvis* L.), and that in this fish it is possible to stimulate the germinal epithelium to abnormal mitotic activity, and consequently to the production of abnormal numbers of oogonia, by abdominal injections of œstrin.

Similar injection experiments have now been performed on the mouse in an attempt to produce the same effect, and after preliminary work, the following technique was devised. Twelve-hourly injections of œstrin in sesame oil were given abdominally into normal mice in early diœstrus, and the mice were killed 12 hours after the last injection. The germinal epithelium is relatively quiescent during the whole diœstrous period, which lasts on the average about three days[3]. At each injection 250 I.U. of œstrin in 0·25 c.c. of oil were introduced, and the liquid was directed into the vicinity of the ovaries. To facilitate the study of mitoses, 0·1 mgm. of colchicine in 0·25 c.c. of water was injected into each mouse 9½ hours before killing. Unusual mitotic activity of the germinal epithelium was noted after only one injection, but the maximum effect was not produced until after five injections. In the accompanying table the average number of mitoses per ovary (a) and the standard deviation from the mean (σ) are given.

The first group, controls receiving no œstrin, showed an average total number of only twenty-five mitoses per ovary. As none of the mice had ovulated, it must be assumed that the large numbers of mitoses obtained in the other groups were due to the effects of the injections. The ovaries of all the injected animals contained far greater numbers of mitoses than the most active of the control animals, but there was very considerable individual variation in all groups. Maximum numbers were found in the germinal epithelium of a mouse which after four injections contained 1,255 mitoses, and in another which after five injections contained 1,818 mitoses.

Average numbers of mitoses of the germinal epithelial cells in control and experimental ovaries.

Number of œstrin injections	Number of mice	Mitoses per ovary a	σ
0	12	25	14
1	5	122	67
4	5	664	493
5	4	747	728

It is concluded that, in the normal mouse, the bursting of the Graafian follicles at ovulation releases follicular fluid rich in female sex hormone. This comes into direct contact with the germinal epithelium, causing the observed post-ovulation peak of mitotic activity, and resulting in the replenishment of the ovary with a new stock of oogonia. Recently, other evidence has been brought forward[4] which indicates that œstrin normally causes mitosis and consequent growth in the follicles and corpora lutea, and that it induces the division of cells of the ovarian stroma. It is well known that relatively small quantities of œstrin will cause mitotic activity in the cells of the female accessory sexual organs, but it appears that the ovarian cells require far higher concentrations and are only induced to divide actively when in direct contact with highly concentrated solutions of the female sex hormone in follicular fluid.

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[3] Bullough, W. S., *J. Endocrin.* (in the press).
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Relation of Aeration to the Activity of Proliferation-Promoting Factors from Injured Cells*

IN earlier tests of the proliferation-promoting activity of materials from injured cells ('intercellular wound hormones') in which yeast was used as the test organism[1], the test cultures were grown in rocker tubes with continuous shaking[2]. This subjected them to appreciable aeration. In recent investigations of wound hormones, yeast was again employed as the test organism, but was cultured in stationary, cotton-plugged tubes suspended in a water bath. At intervals of several hours, the tubes were removed from the water bath, shaken, and the yeast population determined with a photo-electric densitometer. In these later experiments, all preparations failed to show appreciable activity, though they had been prepared strictly in accordance with previously used techniques[1].

It was noted that the cultures containing wound hormone preparations frequently exhibited a ring of yeast growth around the inside of the tube at the air-medium interface. This suggested the possibility that the wound hormone preparations are only effective in the presence of oxygen. Furthermore, Fardon, Norris and co-workers[3], in their original investigation of the metabolic effects of products from ultra-violet irradiated yeast, found such preparations to stimulate cell respiration markedly. Hence it appeared possible that the proliferation-promoting action involved the respiratory mechanism of the cells.

To test this point, a roller tube device was constructed in which the cultures, in 3/4-in. test tubes, are attached to a wheel near its periphery and parallel to its axis of rotation. The plane of the wheel is inclined at an angle of approximately 15° from the vertical. This angle is sufficient to prevent wetting of the cotton plugs by the medium in the tubes, while the almost horizontal tube position maintains a large surface of medium exposed to the tube atmosphere. Rotation of the wheel at 54 r.p.m. provides sufficient stirring to prevent sedimentation of the organisms except in extremely dense populations and to aerate the culture to an extent presumably comparable with that obtained in the rocker tube experiments.

Growth Tests of Wound Hormone Preparations
Wet Weight of 24-Hour Yeast Crops, mgm. per ml. of culture
Concentration of materials tested : 0·1 ml. per ml. of culture.

	Stationary tubes	Roller tubes
Product from Injured Cells ...	0·16	4·05
Product from Uninjured Cells ...	0·18	0·70
Control (Reader's medium only)...	0·15	0·09

When wound hormone preparations, inactive in the stationary tube cultures, were tested in the roller tubes, they showed marked activity. A typical example is shown in the accompanying table. The preparation tested in this instance was the cell-free suspension medium obtained from yeast injured by 8-hour irradiation with full ultra-violet radiation in distilled water at a concentration of 100 mgm. wet weight of yeast per ml. Its activity is compared with that of a similar extract from non-irradiated yeast. Considerable cell death (about 6 per cent) necessarily occurred in the non-irradiated suspension due to the prolonged extraction in distilled water ; hence this extract, as well as that from the irradiated cells, would be expected to show some wound hormone activity.

The necessity of aeration for growth activity of the wound hormone preparations is apparent from

* Contribution No. 199 from the Department of Biology, Massachusetts Institute of Technology, Cambridge, Mass.

the table. These results have been confirmed by repeated tests in which the progress of growth at various concentration-levels of added materials has been followed at frequent intervals for periods as long as 82 hours. Full details of the experiments will appear elsewhere. Attention should be directed to the greater growth of control cultures in stationary tubes than in roller tubes. This has been observed repeatedly. The explanation is not known.

The results strongly indicate that the wound hormone activity of products from injured cells is due to the factor or factors involved in the respiratory mechanism of the cells. The similarity of the spectra of wound hormone preparations to those of adenine nucleotide complexes[1], the indicated presence of adenine, pentose and phosphorus, and the absence of pyrimidines[5] would suggest the possibility that the active principle might be diphospho- or triphospho-pyridine nucleotide. Against this possibility there are: (1) negative chemical tests for the pyridine ring[1]; (2) negative spectral indications of coenzyme I or II on reduction of the preparations with sodium hyposulphite; (3) negative biological tests for coenzyme I in our preparations. The spectral tests of oxidized and reduced preparations were undertaken in collaboration with Prof. Sizer of our department. The biological assay for coenzyme I was carried out through the kindness of Prof. Ball of the Biochemistry Department of Harvard Medical School by Mr. Jandorf of his laboratory. The possibility of the identity of the active factor with other adenyl nucleotide complexes, such as adenine pyrophosphate, yeast adenylic acid and muscle adenylic acid, is being investigated.

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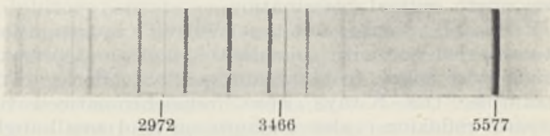
A Remarkable Green Line Source

IN a number of communications in these columns I have reported the observation of high relative intensities of forbidden lines of atomic nitrogen and the forbidden bands of molecular nitrogen in nitrogen afterglows. Both the absolute and relative intensities of these radiations increased with pressure over the range which had been studied up to the spring of 1941. This included pressures from about 0·001 to 30 mm. In addition, the relative intensities increased as the time between the interruption of the afterglow producing discharge and the exposure of the afterglow was increased[1]. This effect has been referred to as the temporal effect.

One of the tubes that had been used during the previous studies was cleaned and refilled with nitrogen at the high pressure of 100 mm.[2]. This tube developed a strong afterglow in a remarkedly short time, and in a few days it showed an afterglow so rich in the green auroral line that after the first half-second the afterglow was coloured green and the green line could be seen for several seconds in a vision spectroscope. The spectrum which was chosen for reproduction here shows that after the first flash of



AFTERGLOW SPECTRUM 100 MM. PRESSURE NITROGEN WITH TRACE OF OXYGEN; FIRST HALF-SECOND OF AFTERGLOW NOT PHOTOGRAPHED.

the afterglow during which the first-positive and second-positive bands of N_2 are considerably weakened, we have an almost monochromatic source of the green auroral line in the visible. The large intensity of O I $^1S_0$-^3P, which has about one thirtieth the transition probability of the green line O I $^1S_0$-$^1D_2$, shows in a striking manner the remarkably efficient excitation of the green line. In addition, one should note the large intensity of N I $2P$-$4S$.

Since the discovery of this source, another similar tube at 50 mm. has been prepared, and this, too, shows equally strong forbidden oxygen and nitrogen line excitations. Therefore, the effect must be due to some change in the tube other than pressure. Other features of the afterglow show up as the small amount of oxygen disappears. Among these is the unexpectedly large intensity of the first-negative (auroral) bands of N_2^+ at both 50 mm. and 100 mm.; the large intensity of the Vegard-Kaplan bands and the large intensity of the green line when much of the oxygen has cleaned up.

These results and a proposed hypothesis to account for these tubes will be presented later, but one conclusion is already tempting, namely, that the catalytic effect of the walls of the tube for the destruction of active nitrogen has in some way been removed and the tube behaves effectively as if it had *no walls*. The large intensities of the two most striking components of the auroral spectrum, the green line and the auroral bands, lend considerable weight to this conclusion, because both ions and metastable atoms are effectively quenched at walls.

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[1] Kaplan, J., *Phys. Rev.*, **57**, 662 (1940).

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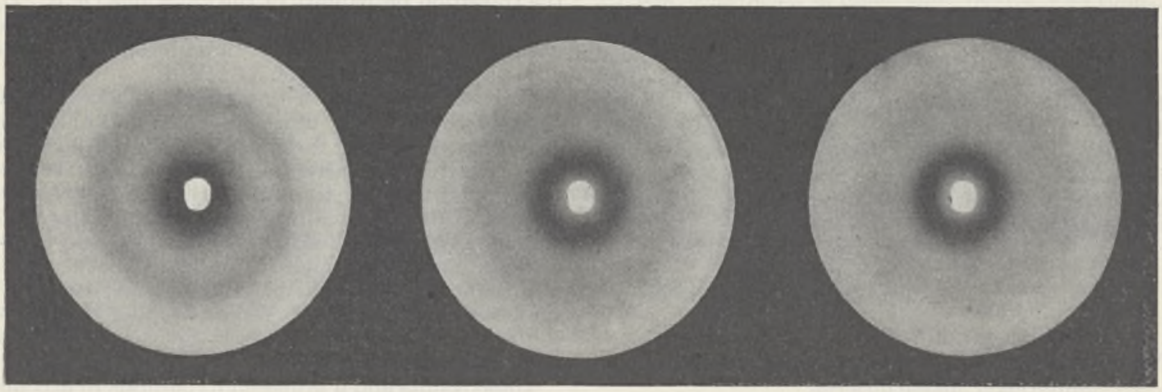
Structure of Vitreous Silica

OUR attention has recently been directed to a letter from S. S. Lu and Y. L. Chang[1] concerning the structure of vitreous silica. Two main claims are made. First, that the X-ray diffraction pattern of a thin plate of vitreous silica differs from that of the powdered material and consequently there must be some rearrangement of structure on powdering. Secondly, that the relative intensities of two strong bands in the pinhole transmission photographs of the thin plate vary according to the location of the specimen and that this indicates that large fluctuations occur in the structure of vitreous silica. Since, if true, these results would appear to suggest that the random network theory developed by Warren[2] is based upon incomplete experimental data, the experiments and conclusions described in the letter are worth critical examination.

It may be pointed out that Warren's investigation was carried out with considerable care, and precautions were taken to eliminate spurious effects. For example, the X-rays were monochromatized by crystal reflexion ; also background and small-angle scattering were reduced to a minimum by evacuating the camera. There is no precise description in Lu and Chang's letter of the experimental arrangements for taking the X-ray patterns, but it does not seem that crystal-reflected X-rays were used. It must be assumed, therefore, that the more usual method of filtration was utilized to obtain the copper $K\alpha$ radiation and that there would consequently be a white radiation component of the X-ray beam. The presence of this would provide a simple explanation of the particular form of the pinhole transmission photographs obtained by Lu and Chang. Broadly speaking, they obtained two strong bands in the transmission photographs of a thin plate of vitreous silica, thickness 0·5 mm. These bands could be derived from the same fundamental spacing in the glass structure, the outer band at 4·09 A. from diffraction of the characteristic $K\alpha$ radiation and the inner band at 8·18 A. from diffraction of the white radiation. A thickness of 0·5 mm. is too great for use with copper $K\alpha$ radiation, which would be substantially absorbed ; there would be differential absorption of the X-ray beam actually employed, the shortest wave-length part of the white radiation being much more readily transmitted than the longer wave-length characteristic radiation.

In order to test this we have obtained pinhole transmission photographs over the thickness range 0·5–0·05 mm., using filtered copper $K\alpha$ radiation. These show that the relative intensity of the inner band decreases continuously with the specimen thickness, the band effectively disappearing below about 0·1 mm. Three of these photographs corresponding to thicknesses of 0·05, 0·43 and 0·50 mm. are reproduced here. The blackening near the centre of the pattern of the 0·05 mm. specimen arises from small-angle scattering by air of long wave-length components (largely no doubt the copper $K\alpha$ wave-length) of the X-ray beam. Such blackening is much reduced on the other patterns because of substantial absorption of these wave-lengths by the thicker specimens.



0·05 mm. 0·43 mm. 0·50 mm.

By varying the tube voltage we have also confirmed that the position of the band changes with the wave-length distribution of the white radiation. These results provide strong evidence that in Lu and Chang's photographs the inner band is spurious and probably arises in the way we suggest. It is obvious that changes in the intensity of this band cannot be significant of structural variation between contiguous regions. Such intensity fluctuations might result from small changes in the experimental conditions and from any variation in thickness.

The faint but comparatively sharp lines at 3·35, 2·48 and 1·88 A. appearing in some of Lu and Chang's powder photographs correspond closely in position to three of the strongest lines in the X-ray pattern of crystalline quartz. These are just the lines which would be most likely to occur as the result of contamination of the powder with material from an agate mortar during grinding. In regard to the band at 5·80 A., it would be interesting to know what kind of medium was used for holding the powder together in the form of a cylindrical rod. Canada balsam, for example, gives a band in this position. Using the minimum quantity of cellulose binder, we have obtained a pinhole transmission photograph of a slab of powder which shows no evidence of a band in the region of 5·80 A. The photograph of the powdered material is, in fact, very similar to that of a 0·25 mm. plate.

It is therefore reasonable to conclude from these results that the bands at 8·18 and 5·80 A. obtained by Lu and Chang are spurious, and the changes they report should not, therefore, be taken as evidence of variation of structure either between neighbouring regions of a slab of vitreous silica or on powdering. Furthermore, there would seem to be no reason to suppose that the random network theory of Warren does not cover the facts.

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RESEARCH ITEMS

Incomes in Rhodesia

IN a paper reprinted from the *Transactions of the Rhodesia Scientific Association* (38, 63–73; April, 1941) J. R. H. Shaul has used the published returns of the Commissioner of Taxes in his annual report for the year ended March 31, 1938, which covers the year 1936–37, and the results of the census of population, 1936, to examine the distribution of incomes originating in Southern Rhodesia in 1936. Within certain limits, these incomes can be accurately described by Pareto's law. Formulæ are given for all incomes, for married persons and for other persons, and the available evidence suggests that the formula for all incomes changes its gradient at £350 and can therefore be utilized only in respect of incomes exceeding £350. Below £350 the following hypothetical expression for Pareto's law is deduced:

$$\log y = 5{\cdot}457 - 0{\cdot}515 \log x \; (2{\cdot}053 < \log x < 2{\cdot}544).$$

The hypothetical formula for the distribution of income in Southern Rhodesia is:

$$\log y = 9{\cdot}558 - 2{\cdot}127 \log x \; (\log x < 2{\cdot}544)$$
$$\log y = 5{\cdot}457 - 0{\cdot}515 \log x \; (2{\cdot}035 < \log x < 2{\cdot}544).$$

Petrology and Prehistory

AN important article on this subject appears in the *Proceedings of the Prehistoric Society* for 1941 under the signatures of A. Keiller, Stuart Piggott and F. S. Wallis. A large number of stones celts have been studied microscopically, a tiny portion of each tool being sliced and the outer surface of it replaced in such a way that finally it is almost impossible to detect that anything has been done to the specimen —compare the technique of the cheese-taster! The composition of the rock having been determined, it is often possible to say with fair accuracy whence came the raw material from which the tools were made. Naturally this information can help in elucidating prehistoric trade routes, or at any rate can throw light on the movements and contacts of peoples. For example, it is apparent "that while the most important area supplying the raw material for the stone axes of Wessex was Cornwall, axe-factories in North Wales and Cumberland exported their products as far south as Wiltshire at least". Such investigations, when continued further, will certainly yield very fruitful and often exciting results.

Inhibition of Growth by Chemical Compounds

MANY carcinogenic hydrocarbons retard the growth of both normal and malignant tissues and an association exists between the biological properties of carcinogenicity and growth inhibitory power. Tumour induction is conceived to take place in two stages: (1) interference with the growth of normal cells and (2) an adaptive cellular reaction, accomplished mainly by dedifferentiation, where the altered cells are able to achieve independent multiplication at an increased rate in an environment which makes normal growth difficult or impossible for their parent cell. While the new growth characters appear in response to a specific pathological change in the cellular milieu, the cellular changes themselves are permanent and continue to be manifested indefinitely and without reversion when the variant cells reach normal tissues either in the same host or artificially in other hosts by transplantation. With the prospect of discovering compounds possessing enhanced inhibitory activity, but with carcinogenicity restricted, G. M. Badger *et al.* (*Proc. Roy. Soc.*, B, 130, 255; 1942) have investigated the growth inhibitory activity of more than two hundred carcinogenic compounds and related substances. A striking degree of correspondence was often shown by the inhibitory and carcinogenic activity of closely related compounds, such as dibenzfluorenes or dibenzphenanthrenes, although no inhibitory activity was observed for certain carcinogenic 10- and 9 : 10 substituted benzanthracenes. Conversely, inhibitory activity was noted in a few compounds (1 : 2′-azonaphthalene) which have yielded few or no tumours in exhaustive tests, and in some of a group of synthetic œstrogens, which although not carcinogenic in the usual sense are nevertheless associated with the induction of individual types of tumour under special conditions. The results obtained with derivatives of triphenylethylene suggest that inhibitory activity may still be shown by compounds diverging widely from the polycyclic structure and possessing only a skeletal resemblance. In view of the similar inhibitory effects produced on body growth, tumour growth and gonadal activity by the polycyclic carcinogenic hydrocarbons and by œstrogens, carcinogenic in a restricted sense, it is likely that the mechanism in both cases is partly direct and partly moderated by the pituitary.

Streptolysin *O*

MANY strains of hæmolytic streptococci produce filterable hæmolysins. The hæmolytic activity of fresh broth filtrates in which hæmolytic streptococci have grown rapidly disappears on standing in air and can then be restored to the original level or higher by the addition of reducing agents such as hydrosulphite. This hæmolysin (streptolysin *O*) is produced by most strains of group *A* streptococci when grown in serum-free broth, by group *C* strains from human infections and by group *G* strains, but not by streptococci of other groups. Another serologically different hæmolysin (streptolysin *S*) is produced when hæmolytic streptococci are grown in media containing serum, and its activity is not affected by oxidation and reduction. Herbert and Todd (*Biochem. J.*, 35, 1124; 1941) have purified streptolysin *O* and have shown it to be a protein which hæmolyses red blood corpuscles only after activation with reducing agents such as compounds with -SH groups, resembling certain other enzymes, for example, papain, in this respect. A possible explanation of the hæmolytic action of streptolysin *O* is that it is an enzyme which attacks a constituent of the red cell membrane. Although no appropriate substrate has yet been found for the demonstration of its enzymic function, yet the extremely small doses in which all bacterial toxins work suggest that their action must be catalytic. It is noted that two bacterial toxins have already been identified as enzymes, namely, the α-toxin of *Cl. welchii* as a lecithinase, and the 'diffusing factor' of the same organism and of streptococci as a hyaluronidase, and the possibility exists that all bacterial toxins are enzymes.

New Silver Firs from Asia

THE activities of various botanical explorers in eastern Asia have made an immediate contribution to floral beauty in the garden, but the taxonomic and horticultural evaluation of trees is a slower process. Nurseries at Chandlers Ford and Winchester have been used to propagate the newer Asiatic silver firs from seeds collected by Forrest, Wilson, Kingdon Ward and others. Edwin L. Hillier has now described some of the species there which have grown sufficiently to provide reliable specific characters (*J. Roy. Hort. Soc.*, 66, Pts. 11 and 12, Nov. and Dec., 1941). The Chinese silver fir, *Abies Georgii*, and *A. Forrestii* promise well as ornamental trees, and sixteen other species are described in detail, mainly from the horticultural point of view. It is still too early to assess any significance the various species may have for afforestation in Great Britain, but the English material should provide useful data for a future ecological comparison with trees in the native habitat, for most of the original collections are from sites above 10,000 ft. high.

Linkage Studies

F. B. HUTT (*J. Hered.*, 32, 357; 1941) for the fowl, and W. E. Castle and P. B. Sawin (*Proc. Nat. Acad. Sci.*, 27, 519; 1941) for the rabbit, report the discovery of a fifth linkage group. Multiple-spurs are linked with duplex comb in the fowl with a cross-over percentage of 28 per cent. Multiple-spurs which are characteristic of the black Sumatra fowl are inherited as a dominant and may be easily detected in 98 per cent of young chicks. In the rabbit, furless and brachydactyly are linked with a cross-over of 28 per cent, while dwarf is now added to the agouti-wide-band linkage group.

Solar Radiation and Atmospheric Temperature

DR. H. ARCTOWSKI, a well-known Polish meteorologist who was stranded in the United States by the outbreak of war, has been investigating the effect of variations of solar radiation on atmospheric temperature, and his first results have been published (*Smithsonian Mis. Coll.*, 101, No. 5). He found that while in a few cases a direct effect on surface temperatures could be shown, these are exceptions, and he concluded that while solar variations are undoubtedly important, their effects are very complex, and probably occur mainly in the upper air. The greater part of the paper therefore consists of a study of the variations of temperature up to 17 km., mainly on the basis of *radio-sonde* ascents in the United States. Waves of rising or falling temperature, with their accompanying effects on pressure, travel in different directions at different heights, so that the combined effect at the surface is one of almost inextricable confusion, but there is a possibility that a direct effect of solar variation on temperature may occur at some level in the stratosphere. Dr. Arctowski however distinguishes *two* tropopauses, polar and equatorial, which are superposed in temperate latitudes. Very little attempt is made to relate the observed changes of temperature at any height directly to observed variations of the solar constant, and it is evident that many more data are required before there is any hope of a solution of this important problem.

Adsorption of Metals of the Iron Group in Analysis

A PAPER on the above subject was read by G. J. Austin before the Society of Public Analysts and Other Analytical Chemists on February 4. The effect of *p*H on the adsorption and solubility of aluminium hydroxide in analysis has been studied. The ammonia method of separating aluminium from nickel was shown to be impracticable owing to the great increase in the adsorption of nickel over a limited range of *p*H. Data were given comparing the extents to which adsorption takes place in the precipitation of iron, aluminium and chromium by the ammonia method, the benzoate method and the author's phosphate method. Some other methods were also referred to. It was shown that the phosphate method is better than the ammonia method in minimizing adsorption, but that in absence of phosphate the benzoate method is better than the phosphate method.

Solvent Effect and Dipole Moments

IT has been known for some time that the dipole moment of a compound measured in solution may differ from that measured in the vapour state. The reason for this difference is broadly known and the so-called solvent effect has been studied in many cases. In the measurements, both with vapour and liquid systems, the main difficulty is now the estimation of the so-called atom polarization, which cannot be determined directly. By combining the two sets of measurements, some of the uncertainty attached to atom polarization may be removed. A. Audsley and F. R. Goss (*J. Chem. Soc.*, 864; 1941) have now discussed methods for distributing the polarization of binary liquid mixtures between their components. The so-called distortion polarization, the sum of the electronic and atom polarizations, $P_E + P_A$, obtained by the elimination method just mentioned, has been distributed over the carbon, hydrogen and halogen atoms in compounds of the type RX by making use of an additive relation in which $P_E + P_A$ is the sum of contributions assigned to each atom or bond. It is shown that on ascending the series from fluorine to iodine the electron polarization P_E increases but the atom polarization P_A shows a general tendency to decrease.

High-voltage Porcelain Insulators

A PAPER read recently by J. S. Forrest before the Institution of Electrical Engineers discusses the electrical characteristics and performance in service of porcelain insulators for outdoor apparatus for voltages between 33 and 220 kv., and emphasizes the necessity for a carefully planned field-testing scheme supplemented by laboratory investigation if system breakdowns are to be minimized. The first part describes the laboratory and field-testing equipment used by the Central Electricity Board and proceeds to an outline of the technique employed. The second part gives details of investigations made with the apparatus and methods previously described, and information is provided regarding the performance of line insulators, post insulators and bushings, discussing their behaviour under adverse weather conditions. Comparative results are given for normal and anti-fog insulators, the mechanism of insulator flashover in fog being described in detail with suggestions for a good anti-fog insulator. A discussion on the deterioration of insulators in service advocates field testing to prevent single faulty units of suspension insulators leading to a complete breakdown of the string containing them, and describes the mechanism of insulator failure due to cracking. Considerable attention is given to the cause and characteristics of radio interference due to power lines, data being given of the interfering field strength under various weather conditions.

THE SUN AND THE IONOSPHERE

THE thirty-second Kelvin Lecture of the Institution of Electrical Engineers was delivered by Prof. Sydney Chapman on May 8, 1941, and has now been published (*J. Inst. Elect. Eng.*, 88, Pt. 1, No. 11, Nov., 1941). The first part of Prof. Chapman's lecture, dealing with the origin of solar energy by the 'combustion' of hydrogen, was printed in NATURE of June 28, 1941, p. 792.

The process begins when the solar gas has reached a temperature of 20×10^6 °C. and a pressure of 10×10^9 atmospheres near the sun's centre, the 'burning' of the hydrogen nuclei thereafter maintaining the temperature and preventing further contraction for thousands of millions of years. In this reaction, the hydrogen protons are built up into helium nuclei during a six-stage reaction involving a catalyst, which at the outset is an ordinary carbon nucleus $^{12}_{6}C$. The equations of these reactions indicate a few million years for the fertilization of a carbon nucleus by four successive protons to beget one α-particle. If the birth-rate is high at the sun's centre, it is on account of the immense number of carbon atoms and protons.

This catalytic reaction is enormously productive of energy, 1 lb. of hydrogen nuclei evolving radiant energy equivalent to 100 million electrical units, compared to 4½ units for 1 lb. of coal. Energy has a mass of 1 gm. per 25 million electrical units, and hence the radiant energy from 1 lb. of hydrogen nuclei has a mass of 4 gm., by which perceptible diminution the mass of the resulting helium nuclei falls short of 1 lb. For a loss in mass of four million tons/sec. the sun has a heating and lighting output of 10^{24} kw. Radiation leaves the sun with a spectral distribution corresponding roughly to 6,000° C., consisting of highly directional electromagnetic waves, the average frequency of which is nearly a billion kc./sec. In the sun's upper layers the outward flowing radiation energizes many surface phenomena, the most evident being sunspots and prominences. Much solar gas in prominence form leaves the sun, which thus sends forth matter as well as radiation into surrounding space; and this matter, in the form of rare gas streams, assists the solar radiation in the ionization of the earth's outer atmosphere.

All but a tiny fraction of the sun's colossal energy output is lost in space, the earth's input of 170 billion kw. being but one thousand millionth of the parental output. Prior to entry into our atmosphere, this includes radiation of all wave-lengths, which may be resolved into a spectrum containing visible radiation or sunlight proper, ranging from violet to red (3900–7700 A.), and outside this the infra-red and ultra-violet. Much of the sun's light and heat pass through the atmosphere to the earth's surface, but the blue sunlight is dispersed. At an altitude of 15 miles above the atmosphere the sky is dark as at night. Energy absorbed by land and sea energizes almost all living processes, weather phenomena and geological changes, afterwards returning to space as heat radiation. Very little of the sun's radiation reaches the ground, the rest being absorbed at different levels by ozone, oxygen and nitrogen. Between 10 and 70 miles altitude, dissociated oxygen atoms combine with oxygen molecules to form ozone, an extremely rare constituent of the atmosphere, which, if collected at the earth's surface would, at the prevailing temperature, have a thickness less than ⅛ in. This very small amount, spread through 30–40 miles of atmosphere, absorbs all the ultra-violet radiation (from about 2000 A. to 3000 A.), and also some of the visible and heat radiation—in all, about 5 per cent of the whole incident energy. At an altitude of 7 miles, the temperature is 220° abs. (−53° C.), rising with increasing altitude to greater than 100° C., cooling again after a further 25 miles, according to the band spectrum evidence of the Northern Lights.

The absorption of radiation in the extreme ultra-violet end of the spectrum can ionize molecular oxygen and nitrogen, which, absorbing at different levels, can provide a two-layer ionosphere. Appleton recognized the existence of two distinct main ionized layers: the lower or E layer, at 60 miles, and the upper or F layer. The latter in day-time in middle and lower latitudes consists of two parts, F_1 at 130 miles and F_2 at 200 miles. The E layer appears to remain nearly constant in height, whereas the F_2 varies greatly. Absorption of the ionizing solar radiation is more likely to be due to molecules than to atoms. Molecular nitrogen extends upwards for hundreds of miles above the ground, whereas molecular oxygen is probably scarce at 70–80 miles; hence the ionized nitrogen layer is likely to be situated above the ionized oxygen layer and we may probably identify the nitrogen layer with F, and the oxygen layer with E. Appleton and Hulbert consider that the temperature of the F_2 layer rises, due to some radiant energy being absorbed and converted into heat within the layer, causing an upward expansion and rarefaction of the layer and demanding remarkably high temperatures of the order of 1,000° abs. Such temperatures imply large random molecular velocities in the F_2 layer, weakening the earth's gravitational attraction on the air there, especially for hydrogen and helium, which probably leak away into space. Helium has constantly been reproduced radioactively from the earth's crust for more than a thousand million years, but the atmosphere does not contain the corresponding amount of helium. When the layer cools in the late afternoon it sinks, producing the abnormal second maximum of ionization.

Solar control of the ionosphere is indicated by the change in electron density following the 11-year sunspot cycle, the ionization having changed by 50–60 per cent between the sunspot minimum of 1934 and the sunspot maximum of 1937, implying a still greater increase, of 120–150 per cent, in the ultra-violet intensity. A similar change has long been revealed in the intensity of the system of electron currents flowing in the upper atmosphere, by their daily magnetic field variation, and this gave the first indication of an ionosphere, long before the advent of radio communication. The most remarkable irregular ionospheric changes are those associated with magnetic storms, causing long radio black-outs of hours or days and slowly rectifying abnormalities in the earth's magnetic field. The F_2 layer is most usually affected, except in high latitudes, where the E region may be intensified and extended downwards to cause a radio black-out resembling those due to solar eruption, except that they may occur at night and be of longer duration. Appleton and his collaborators have discovered that the earth's field imposes a spiral character on the motion of electrons in the ionosphere, making the air anisotropic for the transmission of radio waves, permitting determination of the field intensity in the region of refraction of returned waves; and that the E layer sustains lunar tidal motion twice per lunar day, the ionospheric tide having the unexpected range of about 1 mile, and producing by dynamo action a system of electric currents, detectable by their magnetic effects at the ground, apparently flowing in or below the *E* layer.

There also flows in the ionosphere a system of currents wholly governed by the sun, manifesting themselves by ordinary daily magnetic variations, the total current being about 200,000 amp., roughly ten times as great as those due to lunar tides. The total current intensity in the greater system is only about twice that of a single lightning flash and the current density is extremely low, contributing inappreciably to the heating of the atmosphere. In a quite moderate storm there appears to be an intense current system (more than half a million amperes) in the ionosphere over each polar cap; the magnetic effects over the remaining 90 per cent of the earth betoken a current system of about the same total intensity.

ELECTRONICS IN INDUSTRY

IN May 1941, as a result of considerable interest in the various branches of industrial radiology, the Institute of Physics formed an Industrial Radiology Group (see NATURE, June 7, 1941, p. 706). Recently there has been a widely expressed wish among members of the Institute for the formation of a similar group for electronics. It was decided, therefore, to hold a Conference on Electronics to ascertain whether there existed sufficient interest to justify the formation of such a group. This Conference was held at the Royal Institution on January 28 under the presidency of Prof. J. D. Cockcroft. It consisted in the reading of three papers followed by a general discussion and was well attended, members from many parts of Great Britain being present, as is usual at such meetings of the Institute.

Prof. Cockcroft, opening the proceedings, spoke of the widening field of application of electronic devices, and said that it is becoming increasingly difficult for physicists to keep in touch with developments in such specialist fields. He thought that the Conference would justify itself if it helped to minimize this difficulty.

The first paper, on "The Efficient Production of Light by the Electric Discharge", was read by V. J. Francis of the General Electric Company. The author pointed out that the scientific study of the efficient conversion of energy into radiation by means of electric discharges in gases is comparatively recent. Although the efficiency obtainable is several times that possible by any other known means, in practical lamps the efficiency of conversion is still only 12–15 per cent, and a wide field for research still exists. Under certain ideal experimental conditions, efficiencies as great as 90 per cent have been recorded.

Mr. Francis then discussed the sodium and mercury vapour discharges in order to explain some of the principles involved in obtaining high luminous efficiency. The former requires low pressure and low current density because the resonance radiation is in a useful part of the visible spectrum; while with mercury, where the useful transitions are between excited states, the conditions leading to high efficiency are high pressure and high current density. He then dealt briefly with some of the applications of luminescent powders to discharge lamps. In one interesting application, practically all the light is obtained from the luminescent powder, which is excited by ultraviolet radiation produced with an efficiency of some 70 per cent in the low-pressure mercury vapour discharge. Finally, the possibilities of the mercury vapour discharge as a high-brightness source were mentioned; very high brightnesses are possible by this means.

The next paper, on "The Control Characteristics of Thyratrons and Ignitrons", was given by H. de B. Knight, of the British Thomson-Houston Company. The author first dealt with the dependence of the ratings and control characteristics of hot-cathode thyratrons on cathode emission, on the geometry of the electrodes and envelope, and on the gas or vapour density. In gas-filled valves the density is constant and control characteristics are independent of temperature; but the working voltage is limited to about 500 volts. For high power, mercury vapour is used; but the vapour pressure must be controlled, especially for heavy current densities and high voltages (above 15 kv.) Mr. Knight showed many interesting curves illustrating these characteristics. Ionization time comprises a delay period in which practically no current passes, followed by a shorter 'build-up' period in which the plasma becomes established. Both periods are relatively independent of vapour pressure, but are affected by the grid voltage and resistance, and especially by the shapes of the electrodes and the field distribution in the arc space. De-ionization time is a function not only of valve design but also of the circuit.

In dealing with mercury pool rectifiers, controlled by cathode spot formation, the author said that the 'Ignitron' alone finds wide industrial application. The delay time between the igniter current and the main arc depends on the rate of rise of igniter current. A delay of less than one microsecond can be obtained; but up to 50 microseconds or more is satisfactory for most industrial uses.

A. J. Maddock, of Standard Telephones and Cables, read the third paper, on "Hot-cathode Gas-filled Triodes (Thyratrons) and their Applications in Research and Industry". The author described the various ways in which these devices may be used. An outline of the principles of the several basic circuits that can be employed in most applications was given, and these were illustrated by interesting demonstrations so that the properties of the various circuits and the effects resulting from the use thereof were readily apparent.

The circuits discussed included those for use on A.C. and D.C. supplies, and showed the range of control obtainable in the former case as the point at which the grid loses control in each positive half-cycle of the alternating anode voltage is varied; and in the latter case how a second thyratron or switch may be used to stop the flow of current through a thyratron already passing current by applying a negative impulse to the anode of the first thyratron. Extension of this leads to the inverter circuit which produces an A.C. output from a D.C. input.

Several grid circuits were illustrated suitable for use in covering such applications and control as timing, impulse, variable reactance, variable resistance (including use of photo-electric cells), variable phase, etc. Examples of the use of these devices ranged from circuits for high-speed counting of physical phenomena and the generation of current pulses of accurate time duration used in research to large industrial plants such as high-tension rectifiers developing 600 kw. at 14,500 volts, large variable-speed motors operating on an A.C. supply, and inverters with the possibility of transmission at high D.C. voltages, together with the realization of a virtual static D.C. 'transformer'.

A lively discussion ensued which ranged over a number of topics, and in particular many questions were asked concerning the behaviour and application of the gas-filled triodes. It was clear, as Prof. Cockcroft said in closing the discussion, that there was sufficient interest for the Conference to go on indefinitely, and the Conference passed a resolution requesting the Board of the Institute of Physics to sanction the formation of an Electronics Group.

UTILIZATION OF INDIAN HOME-GROWN TIMBERS

A FOREST Bulletin, No. 92, Utilization (New Series), has been written by V. D. Limaya of the Forest Research Institute, Dehra Dun, on "The Testing of Packing Cases for Army Boots and suggested Improvements." (Govt. of India Press, New Delhi, 1941). Packing cases for army boots in India have usually been made of chir (*Pinus longifolia*) in the past. Owing to the large demand brought about by the War, other timbers for the purpose have come under review. The Ordnance Department suggested that semul (*Bombax malabaricum*) might answer equally well and would be more easily available as the species is not more or less confined to the outer hills of the Himalayan range. Since, however, it is a softish wood, doubts were expressed as to its suitability. Comparative tests of both timbers were therefore undertaken in the Timber Testing Section of the Institute. These tests showed that semul boxes were practically as strong as chir boxes and possessed in addition certain advantages. But the tests went further, and indicate how war-time emergencies sharpen the faculties. It was discovered that the original design could be greatly improved so as to produce a far stronger box by very small additions costing not more than two annas a box. Boxes so made were tested and found to be fifteen times stronger than those made according to the original design. The advantages to an army at war will be readily understandable. Two plates show the old box and its failure to stand certain stresses and the new one.

Bulletin No. 93, by the same author, is entitled "Indian Timbers for Tool Helves and Handles". When there has been a Forest Department in India for nearly eighty years and a Research Institute for well over thirty, it is difficult to account for the fact that up to quite recently very large quantities of hickory and ash handles were imported from America into India annually. In fact the big American manufacturers were doubtless correct in saying that "We 'handle' the World". Hickory only grows in the lower Mississippi valley and yet hickory tool handles and helves are to be found in use in practically every country in the world. Ash is also used to a very large extent for the lighter types of handles. These two species have very nearly monopolized the tool handle trade of the world. Until comparatively recently this remained true for India in spite of the large number of species growing in the great Indian forests.

The work carried out at the Forest Research Institute has, however, resulted in greater interest being taken in Indian timbers in this respect, with the result that more than three quarters of the railway demand for tool handles (the largest demand in the country) is now met by handles made in India from Indian woods.

The author states that "wooden handles for tools are really becoming a world problem". Manufacturing processes require the use of various types of cutting tools and hammers and the demand for wooden handles for such tools has increased enormously. While admitting that hickory is rather a special type of timber and that it will probably remain in demand for special uses, it is now proved that certain Indian timbers fulfil the requirements for tool handles. The research work of the Timber Testing Department had resulted in the markets being supplied with tool handles made from Indian timbers, and the War has given a great impetus to the tool handle trade, large orders having been placed for pick-axe helves, hammer handles, axe-helves, wooden mallets, handles for entrenching tools, spades and so forth.

Some of the species of timbers used belong to about twenty genera. These, according to their qualities, are used for heavy hammer handles (hickory class), light hammer handles (ash class), axe helves (hickory class), handles for scooping tools (ash class) and handles for cutting tools (beech class). Other woods of small forest species are being tested. For example, *Anogeissus pendula*, which until recently was practically unknown as a tool handle wood, has been found to be the toughest timber ever tested.

DOWNWARD RADIATION OF THE EARTH'S ATMOSPHERE

IN Scientific Notes of the India Meteorological Department (8, No. 93) R. Narayanaswami gives a comparison between measurements of the downward radiation of the earth's atmosphere at night made by himself at Bombay between March 1937 and October 1938 and similar observations by Ramanathan and Desai at Poona in 1930–31. The interest of the comparison lies in the fact that the climates of the two places are in strong contrast, Bombay having a coastal climate of exceptional dampness, while at Poona the climate is continental apart from the rainy season (June–September), and at times very dry, the annual rainfalls being about 70 in. and 27 in. respectively.

The instrument used both at Bombay and at Poona for measuring the atmospheric radiation was Angstrom's pyrgeometer No. 48, made by G. Rose of Upsala. With this was measured the net radiation per horizontal square centimetre, that is, the difference between the full emitted black body radiation given by σT^4 and the radiation received from the atmosphere, interest attaching mainly to the comparison between the ratio sky radiation to full radiation, and the vapour pressure of the air around the instrument calculated from the readings of an Assmann psychrometer. Since the radiation from the sky is practically all due to the water vapour in the atmosphere, dry air being an exceedingly bad radiator, in so far as there is considerable positive correlation between the water vapour pressure near the ground and in the overlying atmosphere as a whole, so the ratio $S/\sigma T^4$, where S is the sky radiation, and the vapour pressure near the ground, show high positive correlation. Comparison between these quantities and the dry-bulb reading of the Assmann psychrometer is made by tables and graphs.

Throughout the year, except possibly in October, the excess of S at Bombay compared with Poona is almost as marked as is the excess there of vapour pressure. An interesting point confirming that it is mainly the annual variation of vapour pressure that causes the annual variation of S and not the annual variation of temperature is to be noted at the onset of the monsoon in June. Temperature falls but vapour pressure and cloudiness increase in the monsoon current, with the result that S continues high. The lowest observed value of S at Bombay was 0·41 gm.cal./cm.^{2} and the highest 0·66 gm.cal./cm.^{2}. At both places the maximum for S is in the monsoon and the minimum in the winter.

FORECASTING MONSOON RAINFALL

IN Scientific Notes of the India Meteorological Department (8, No. 95) V. Doraiswamy Iyer and C. Seshachar have usefully extended some work done by Sir Gilbert Walker in 1921 on the forecasting of the monsoon rainfall of Mysore State as a whole from the three factors: mean atmospheric pressure over India in the preceding May, Zanzibar rainfall in the same month, and Java rainfall for the period October–February. The multiple correlation coefficient obtained in this way was + 0·57.

It is shown by means of a map of normal monsoon rainfall (June–September) that Mysore includes two regions of widely different rainfall, the *Malnad*, which is a narrow strip of country adjoining the Western Ghats, with a monsoon fall varying from 30 in. to more than 300 in., and the *Maidan*, or plain country, which lies farther to the east and includes most of the State, with a fall of less than 30 in. Monthly normals show that in the *Malnad* July is much the wettest month, followed by June and August, whereas the rainfall of the *Maidan* is greatest from May to October with a much less pronounced maximum spread over September and October. It is known, further, that a strong monsoon circulation favours the rainfall of the *Malnad*, whereas a weak monsoon is more productive of the heavy convectional showers that give the *Maidan* a large part of its rainfall. The expectation that higher correlation coefficients might be expected for each of these regions considered by itself, when the factors used are those most suitable to each rainfall regime, than the one found by Walker for the whole State was fulfilled.

Using a number of new factors, which included sunspot numbers, multiple correlation coefficients of 0·60 and 0·70 were found for the *Malnad* and *Maidan* regions respectively. The work was extended in the case of the *Maidan* to the period September–November so as to include the two wettest months for that region, and for forecasting the rainfall of this period a multiple correlation coefficient of 0·75 was found. The factors used in this case were the *Malnad* rainfall for the previous June–August, Bangalore mean winds at 2–3 km. height in July and August and mean India pressure gradient in July and August. The effectiveness of each of the three formulæ is roughly illustrated by graphs of calculated and observed rainfall over a long period of years. These suggest that the forecasts would be of value to engineers concerned with water supply and to agriculturists, in spite of occasional failures due to the fact that the basic correlation coefficients fell very far short of unity.

FORTHCOMING EVENTS

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

Saturday, March 7

GEOLOGISTS' ASSOCIATION (at the Geological Society of London, Burlington House, Piccadilly, London, W.1), at 2.30 p.m.—Mr. W. P. D. Stebbing: "A Review of References to Geology and Allied Subjects from the 16th Century" (Presidential Address).

Monday, March 9

ROYAL GEOGRAPHICAL SOCIETY (at Kensington Gore, London, S.W.7), at 5 p.m.—Capt. D. L. Leach: "The Survey of Sarawak".

Tuesday, March 10

CHEMICAL ENGINEERING GROUP (SOCIETY OF CHEMICAL INDUSTRY) (joint meeting with the INSTITUTION OF CHEMICAL ENGINEERS) (at the Geological Society, Burlington House, Piccadilly, London, W.1), at 2.30 p.m.—Mr. N. Fleming: "Noise and its Suppression".

ILLUMINATING ENGINEERING SOCIETY (at the Royal Society of Arts, John Adam Street, Adelphi, London, W.C.2), at 2.30 p.m.—Discussion on "Advance Planning in Lighting Reconstruction", to be opened by Mr. Howard Robertson.

ROYAL INSTITUTION (at 21 Albemarle Street, London, W.1), at 2.30 p.m.—Sir Lawrence Bragg, F.R.S.: "Metals", 2: "Metal Geography".*

Friday, March 13

ROYAL SOCIETY of ARTS (INDIA AND BURMA SECTION) (at John Adam Street, Adelphi, London, W.C.2), at 1.45 p.m.—Colonel Sir Arthur Olver: "Animal Husbandry in India".

APPOINTMENTS VACANT

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

LECTURER (WOMAN) IN MATHEMATICS—The Secretary, Somerville College, Oxford (March 10).

EDUCATIONAL PSYCHOLOGIST—The Secretary for Education, Education Offices, York (March 12).

DEPUTY BOROUGH ELECTRICAL ENGINEER—The Town Clerk, Town Hall, Sunderland (endorsed 'Appointment of Deputy Borough Electrical Engineer') (March 14).

ENGINEERING ASSISTANT—The Chairman, Mid-Kent Water Company, Snodland, Kent (March 15).

ORGANIZER OF AGRICULTURAL EDUCATION for the Administrative County of Kesteven—The Clerk to the County Council, County Offices, Sleaford, Lincs. (March 16).

LECTURER IN ANATOMY—The Secretary and Registrar, University, Bristol (March 16).

SCIENTIFIC ASSISTANT (WOMAN NOT LIABLE FOR NATIONAL SERVICE)—The Deputy Director, Imperial Bureau of Pastures and Forage Crops, Agricultural Research Building, Penglais, Aberystwyth (March 21).

TEACHER WITH HIGH QUALIFICATIONS IN BIOLOGY—The Headmaster, The School, Dartington Hall, Totnes.

BIOCHEMIST (MAN OR WOMAN) IN THE PATHOLOGICAL LABORATORY—The General Superintendent and Secretary, Salford Royal Hospital, Salford, Lancs.

REPORTS and other PUBLICATIONS

(not included in the monthly Books Supplement)

Great Britain and Ireland

The Advancement of Science: the Report of the British Association for the Advancement of Science. Science and World Order: Transactions of a Conference of the Division for the Social and International Relations of Science. Pp. 120+vi. ((London: British Association.) 5*s*. [102

The Future of Auditing. By a Group of Accountants in Industry. (A Series of Four Articles reprinted from *The Accountant*). Pp. 28. (Potters Bar: Gee and Co. (Publishers). Ltd.; London: The City Library.) [102

Medical Research Council: Industrial Health Research Board. Emergency Report No. 2: Hours of Work, Lost Time and Labour Wastage. Pp. iv+26. (London: H.M. Stationery Office.) 6*d*. net. [112

Other Countries

Rubber Research Institute of Malaya. Abridged Annual Report. 1940. Pp. 19. (Kuala Lumpur: Rubber Research Institute of Malaya.) [92

U.S. Department of Agriculture. Technical Bulletin No. 784: The Wheat Jointworm in Oregon, with Special Reference to its Dispersion, Injury and Parasitization. By T. R. Chamberlin. Pp. 48. (Washington, D.C.: Government Printing Office.) 10 cents. [92

Records of the Geological Survey of India. Vol. 75, Professional Paper No. 11: A Study of Certain Indian Coals. By E. R. Gee. Pp. iii+46+v. (Calcutta: Geological Survey of India.) 2 rupees; 3*s*. [112