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CONTENTS

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THE SCIENCE OF HUMAN RELATIONSHIPS

"IF civilization is to survive," wrote President Roosevelt in a speech to have been delivered in Washington at the Jefferson Day Dinner on April 12, "we must cultivate the science of human relationships, the ability of all peoples of all kinds to live together and to work together in the same world at peace." That last message shows that President Roosevelt was looking to the San Francisco Conference, of which he was to have been chairman, as a great essay in the science of human relationships; and it may indeed be true that an end to wars will only be in sight when we develop that science and perfect our understanding of human relationships in organizations that satisfy their needs more perfectly. This point of view was well put by Dr. J. T. MacCurdy in "The Structure of Morale"; and if there is to be in any true sense a science of peace its basis may be rather the development and application of biology and the social sciences, including psychology, as Prof. Anton J. Carlson suggested in his address "The Science of Biology and the Future of Man" (see *Science*, 100, 437; 1944), for example, than an approach from the economic side, the scientific study of history or the application of scientific method to disarmament.

This is not to say that the latter may not have their place, but attempts at the scientific study of international relations such as Prof. E. H. Carr set out to give in "The Twenty Years Crisis" have not yet led very far. Indeed, from his latest book*, Prof. Carr seems to have abandoned the effort to outline a science of international politics. His study of nationalism is too brief to be more than perfunctory, and roughly half the book is occupied by a discussion of the prospects of internationalism; this, although the scientific approach is abandoned, is highly pertinent to discussions on the Dumbarton Oaks proposals and the proceedings at San Francisco.

Prof. Carr's sketch of the rise of nationalism from the sixteenth and seventeenth centuries to its climax between 1914 and 1939 in the totalitarian State attributes the latter to three factors: the socialization of the nation, or the bringing of new social strata into the effective membership of the nation; the nationalization of economic policy; and the geographical extension of nationalism as seen in the increase in the number of nations. That last factor, especially in relation to the principle of self-determination, Prof. Carr has already closely analysed in "Conditions of Peace", and his discussion of the prospects of internationalism is no less realistic in the present volume. He challenges and rejects forthright the claim of nationalism to make the nation the sole rightful sovereign repository of political power and the ultimate constituent unit of world organization. He equally challenges the principle of "the sovereign equality of all peace-loving States" of the Moscow Declaration of October 1943, which although embedded in the Dumbarton Oaks proposals is, as was

* Nationalism and After. By Prof. Edward Hallett Carr. Pp. vi+74. (London: Macmillan and Co., Ltd., 1945.) 3*s*. 6*d*. net.

pointed out in the recent debate, by no means consistent with that scheme, apart altogether from the vexed question of the voting formula.

Within its limits, Prof. Carr's little sketch and analysis is a sound contribution to lucid thought about the Dumbarton Oaks scheme, and a number of his points were emphasized in the debate in the House of Commons on April 17. The right of equality, like the right of freedom, he holds, is one that can only be attributed to individuals, not to nations; the equality of nations is not only unattainable, but also neither equitable nor desirable. Like the Grotius Society and M. Lauterpecht in "The Law of Nations, the Law of Nature and the Rights of Man", Prof. Carr comes down firmly on the side of the individual. "The driving force behind any future international order," he writes, "must be a belief, however expressed, in the value of individual human beings irrespective of national affinities or allegiance and in a common and mutual obligation to promote their well-being."

Prof. Carr does not, however, visualize a supreme world directorate as an immediate objective; the sense of unity of mankind is not yet strong enough to sustain such an authority. While a world organization may be a necessary convenience and a valuable symbol, the intermediate unit is more likely to be the operative factor in the transition from nationalism to internationalism. The same caution is applied to schemes of world-wide economic organization. Nations have ceased to be convenient or even tolerable units for this purpose, and the world is not yet ready for a single comprehensive world unit. Meanwhile, the socially and internationally descriptive tendencies inherent in a multitude of planned national economies must be countered by multi-national and international planning.

As to the size and nature of such intermediate units, Prof. Carr points out that they should be appropriate for the particular end in view; and accordingly he welcomes the functional principle and the development or extension wherever appropriate of the numerous agencies of this type set up to serve the war purposes of the United Nations. Moreover, he holds that bodies like the United Nations Relief and Rehabilitation Administration and the Food and Agriculture Organization, which have been conceived on a universal basis, will be effective only in so far as they create separate organs for specific purposes in different areas. Part of the value of such functional bodies lies in the fact that, operating on national territories with the tacit or explicit consent but not formally derived authority of the national governments concerned, operating without regard to divisions or distinctions between different countries, and without affecting the sovereign powers of the national governments, they foster that multiplicity of authorities and loyalties which is essential to the health both of an international and of a national community.

This view of a developing organism rather than of a created mechanism is reflected in American opinion quoted by Prof. Carr, and seemed to be the dominant attitude to the Dumbarton Oaks proposals as expressed in the recent debate in both Houses of Parliament. It was very clear that the scheme for a Security Council was accepted only as the best that could be obtained at the moment. At the same time, as Sir George Schuster pointed out, we need not assume that there will always be disagreements between the Great Powers, though it would indeed be foolish to assume that Great Britain, the United States and the U.S.S.R. will always see eye to eye on international questions of every description. It should be remembered that the peace settlement will be made, not by the new organization proposed at Dumbarton Oaks, but by the victorious belligerents; and that, as Sir Arthur Salter pointed out, for about five years at least, the main interest in the international political sphere will be in the peace settlement organization of the United Nations, and above all in Britain, the United States and the U.S.S.R. If in those years they can, as Mr. Churchill has expressed the hope and conviction, work together for the establishment of world peace and order and demonstrate that they can use their power to serve all nations, an entirely different attitude may prevail towards the present proposals when the Security Council really becomes effective.

Sir Arthur Salter was urging that too much should not be expected of the new organization at the start, and that the limits of its responsibilities should be clearly and widely understood, so as to avoid disillusionment and loss of prestige when the new organization begins to function. For the same reason, the voting procedure may well be accepted as a temporary measure, provided it is open to review and modification in the light of experience.

Although there was clear realization that the deliberations at San Francisco are unlikely to lead directly to a new world State, to a world police force or a federal Europe, the importance of the Conference and of agreement was fully appreciated also. Prof. Carr's prediction that the world would have to accommodate itself to the emergence of a few great multinational units in which power will be mainly concentrated—units, which culturally may best be called civilizations—was indeed tacitly assumed as correct, though the solution he suggests to the dilemma of national self-determination, namely, an attempt to divorce international security and the power to maintain it from frontiers and the national sovereignty which they represent, was not mentioned. Very clearly, however, it was hoped that the habit of co-operation and common action by the Great Powers would tend to remove a predisposing cause of war between them; but the whole sense of the debate was with Prof. Carr in his affirmation that no international organization of power will endure unless it rests on certain common principles and pursues certain common purposes, worthy of commanding the assent and loyalty of men and women throughout the world. The unifying power of the ideal of social justice in the contemporary world was well brought out by Sir George Schuster, who sensed the opportunity for leadership now awaiting Great Britain and the importance of a vigorous domestic policy in promoting understanding and *rapprochement* with Soviet Russia.

The conception of a balanced structure of international or multi-national groupings both for the maintenance of security and for the planned development of the economies of geographical areas and groups of nations, which Prof. Carr sees as the surest prospect of international advance, has thus a good deal of general support, and readers of his book should be able to follow the San Francisco proceedings the more intelligently for its discerning treatment of some of the fundamental issues. But, while Prof. Carr's impatience of nationalism makes him dismiss its claims a little too lightly, nationalism found a doughty champion in the House of Commons in Sir William Beveridge. Sir William rated public opinion as of no practical importance for the prevention of aggression, but after agreeing on the great difference in strength between nations and the necessity of winning the confidence of all nations in a world organization, defended the idea of sovereign equality and of collective security.

In doing so, Sir William essentially elaborated the argument of his book, "The Price of Peace"*, in emphasizing the importance of establishing the rule of law for all nations. The gist of his thesis is that the abolition of war depends on finding a positive alternative to war as a means of settling disputes between nations. The only alternative which can be world-wide is compulsory arbitration by an impartial tribunal, applied to all disputes and backed by overwhelming force.

Sir William's speech in the House of Commons showed more clearly than his book the difficulties into which his legalistic rather than realist approach leads him. That alone can account for his sponsoring the nationalism which, at the outset of his book, he firmly rejects in so far as it is expressed in sovereignty. Indeed, his real starting point is that from which Lionel Curtis starts in his "World War: its Cause and Cure"†—to which, incidentally, Sir William contributes a foreword—Lord Lothian's Burge Memorial Lecture and his subsequent speech to the House of Delegates and Senate of Virginia on February 17, 1940, as British Ambassador. "To-day an anarchy of sovereign States cannot escape chronic war or preserve individual liberty or create the conditions of prosperity or employment within their own boundaries unless, in some way, they can bring themselves collectively under the reign of a single constitutional law."

With that text, Mr. Curtis has put together the substance of his earlier pamphlets: "Action", "Decision", "Faith and Works" and "The Way to Peace"; but it cannot be said that the work has been skilfully done. There is some repetition, and the argument has scarcely been improved in the process or by his diversions into history and other subjects. Mr. Curtis's sincerity and conviction cannot be mistaken; but they, like his argument, stand out better in the pamphlet form in which they were first given to us. That is unfortunate, for Mr. Curtis's point regarding imperial defence, on which his proposed federal scheme is based, remains unanswered; and there is no indication as yet that that issue was really faced at the recent British Commonwealth Relations conference. If it must be recognized that there are limitations to what can be achieved at San Francisco, the very arguments regarding flexibility and an experimental and provisional approach, which were heard in Parliament, are the more reason why the British Commonwealth should make a further attempt to deal with its own problem and give the world a demonstration of the way in which a solution may be found to the larger problem.

Sir William Beveridge's legalistic approach was severely handled by Mr. Richard Law in concluding the debate in the House of Commons, but Sir William's view that the world order of to-morrow must be built on compulsory arbitration of all disputes does not constitute the sole feature of his book. Apart from the merits or demerits of his own suggestion, for which he himself disclaims any idea of novelty, pointing out that it was the basis of the Geneva Protocol, the first part of his book is a well-documented account of the experience of the last thirty years, which in itself should help many to form an independent and objective opinion on the Dumbarton Oaks scheme. It is when he passes on to discuss the conditions and methods of peace, and the scope and nature of a supernational authority, that Sir William becomes too formal and tends to overlook the necessity for a process of adjustment, compromise and agreement between those in whose hands power at present resides.

Mr. Law rightly pointed out that such processes and the establishment of confidence go to the building up of a real system of international law as well as of one of security, and he was able to some extent to reassure the House as to the qualifications which were attached to the right of veto of the Great Powers in the Yalta agreement. Mr. Law concealed no difficulties, but like Sir George Schuster he looked rather to the opportunities opening before us at San Francisco and at the inescapable fact that the only alternative to agreement and success is international anarchy, with all the implications which the closing stages of the War gave to that situation. As Lord Cranborne put it: "To-day we have another chance—it may be the last—to lift humanity out of the pit into which it has fallen. We must not, we dare not fail."

On the success of that effort depend not merely the material welfare of mankind but also the continued advance of science and every other cultural and creative activity. Moreover, though few will entertain false hopes as to the outcome of the deliberations at San Francisco or as to the immediate possibilities of whatever international organization may be set up as an outcome of that Conference, we may well reflect that we may be witnessing the approach to a science of international relationships. It is not merely that we may use organizations set up during the War for peace-time purposes, and thus promote the good will and understanding upon which international co-operation in any field, technical or political,

* The Price of Peace. By Sir William Beveridge. Pp. 104. (London: Pilot Press, 1945.) 6*s*. net.

† World War: its Cause and Cure. By Lionel Curtis. Pp. xx+274. (London: Oxford University Press, 1945.) 7*s*. 6*d*. net.

depends. Sir Arthur Salter has strongly urged the value of the wise use, for example, of the United Nations Relief and Rehabilitation Administration under the direction of a Supreme Reconstruction Council, and others besides him pointed out how relief work could stimulate the integration of the cultural and spiritual as well as the material side of European life. Viscount Hinchinbrooke saw in the problem which Germany itself presents a unique opportunity for an experiment in international government, and there is much in the general attitude to the San Francisco Conference which justifies the belief that something of the method and spirit of science is penetrating into international affairs.

Much clear thinking will yet be required as to the nature and meaning of nationalism; and further study must be made of its problems and the ways and means of mitigating its dangers. But while more than public opinion is clearly required to prevent aggression, Sir William Beveridge is wrong to dismiss it as of no importance. Any world authority must rest upon the support of an informed public opinion, aware of the limitations as well as the possibilities of world organizations, and understanding the restraints which must be accepted as the alternative to anarchy. Part of the task of building a science of peace must be the creation by education of such a world opinion clearly understanding the price of peace. Out of such efforts, reinforced by the scientific investigation of human relationships, designed to encourage the development in due course of an intelligence system comparable with that of the human body, there may be slowly evolved a real science of international relations. Only then can we expect to shape more precisely the large regional and international organizations adapted to serve the needs of men of all nations. Until that time comes, it behoves all men of good will to attempt to appreciate the nature of the problem of international co-operation and its bearing on their own interest and activities both as citizens and professionally; and understanding, to lend their moral support to the efforts of those who at San Francisco or elsewhere are seeking to pave the way to a better and enduring world order.

OCEANOGRAPHIC INVESTIGATIONS

The Oceans

Their Physics, Chemistry and General Biology. By Profs. H. U. Sverdrup, Martin W. Johnson, and Richard H. Fleming. Pp. x+1,087. (New York: Prentice and Hall, Inc.; London: George Allen and Unwin, Ltd., 1944.) 63*s*. net.

SVERDRUP, Johnson and Fleming have answered the demand for an up-to-date manual of oceanography with a comprehensive work, "The Oceans: Their Physics, Chemistry and General Biology". It is a large book with 1,087 pages, amply illustrated by text-figures and charts. It was published two years ago in the United States, but circulation to Great Britain was restricted until the end of last year.

Progress in oceanographical research has been exceptionally rapid during the past twenty years, and the reader is warned in the preface that such recent information must sometimes be coloured in its presentation by the authors' own views. At the risk of premature generalizations, they have preferred definite statements to the enumeration of uncorrelated observations, though without failing to make proper reference to alternative explanations. The success of the book is unmistakable: it will be invaluable to both specialist and beginner. In its treatment of difficult problems it does not take too much for granted, though tiresome over-simplification is avoided.

The authors insist on the close inter-relation of the different aspects of oceanography, and at the Scripps Institution, where the book was written, each aspect is represented by at least one good authority. It is fortunate for the future of oceanographical research that there was such a team, working in sufficiently close co-operation to cover the whole field and achieve successful joint authorship. The Scripps Institution is on the Pacific coast near La Jolla, sixteen miles north of San Diego; it is a department of the University of California. It was founded and equipped by the Scripps family, who have been great benefactors in La Jolla, and derives its funds half from the State of California and half from the Scripps family. Research in all branches of oceanography is encouraged; each section has great freedom, and its own grant for equipment and library. The excellent situation, facilities and atmosphere make it an ideal place for research. Prof. Sverdrup has been the director since 1936, and Johnson and Fleming are assistant professors.

The rapid progress made during the past twenty years is attributed partly to improved technique, and partly to the application of theoretical studies and laboratory research, though the frequent insistence in the book on the need for additional observations shows that theoretical treatment is now often ahead of the work at sea. There are problems which need intensive work by several vessels, and there is still scope for extensive exploration. Where measurements have been made synoptically, over a dense network of observation points, the irregularities in physical properties and water movements have proved much greater than was expected, and they show that great caution must be exercised in drawing conclusions from scattered observations.

The biological chapters make a detailed survey of the factors which control distribution and fertility. It is maintained that animal and plant distributions are not haphazard, but result from orderly events, some historical and some in continual operation. Apparent lack of order is attributed to lack of information. It is emphasized that the distribution and fertility of any species cannot be studied satisfactorily without investigating the whole life-history from egg to spawning adult; each stage may have its own particular requirements.

One of the themes of the biological section is the excellent adaptation of the animals and plants to their environment, and the advantages of sea water as a medium for supporting life. Everything needed for the maintenance of life is carried in solution—the necessary gases as well as the mineral substances—and, except in estuaries, the stability of the physical characteristics makes highly specialized integuments or regulatory systems unnecessary. With few exceptions the marine animals from groups with fresh-

water representatives are larger than their freshwater relatives, and usually the difference is enormous. An improved food supply and more favourable rate of metabolism must be mainly responsible. Respiration is probably easier in sea water owing to the presence of carbonates which facilitate the removal of carbon dioxide; and since the osmotic pressure of sea water is nearly the same as that of the body fluids, no special energy is needed to maintain the proper equilibrium. The gradients of temperature, salinity and light intensity in the sea afford, to those animals that are able to move up and down, the opportunity of selecting optimum conditions. The authors summarize the latest information on all these aspects.

The single-celled plants are shown to be adapted to pelagic life by their microscopic size, and the consequent high ratio of surface area to volume and low sinking-rate. Where necessary they have special structures and shapes, or oil particles, to retard sinking. The most specialized forms are found in the warmer waters, and are associated with the lower viscosity of the warmer waters. It is the microscopic plants which make possible the population of large stretches of ocean; the larger plants, attached in shallow soundings, or specially adapted to a floating existence, are relatively unimportant. The authors suggest that the increased phytoplankton growth frequently observed where waters of different characteristics meet may often be due to the inoculation of a sparse population, living under poor conditions, into favourable water which has lacked the spores necessary to take advantage of the good physico-chemical conditions.

With reference to the statement on page 160 that the average conditions in a body of water comparable in size to the Mediterranean Sea do not change from year to year, it is felt that it would be difficult to demonstrate the absence of random and periodic fluctuations in the average temperature, salinity, oxygen content and contents of minor constituents, from existing data. Nor does it seem very probable that averages over longer periods, say ten years, would fail to reveal some significant changes in the average number of different species of organisms—apart from those due to overfishing. The decrease in phosphate concentration in the English Channel after 1928 and the decline of the herring fishery might be used as counter-evidence; and also the fluctuations in the northern fisheries, which are not entirely attributable to overfishing. These are, however, the fluctuations of a marginal region and rather a special type. There is another relevant statement on page 98, that "for the earth as a whole, the total amount of heat that is received during one year from the sun at the limit of the atmosphere must exactly balance the total amount that in the same period is lost by reflexion and radiation into space. Otherwise the temperature of the atmosphere and the oceans would change." It is not likely that the authors mean to exclude the possibility of small but significant fluctuations in the oceans.

The book gives a very practical account of the methods which have to be used in the absence of direct measurements to compute or estimate the speed and direction of ocean currents. It is worth noting that there is still no better means of judging the accuracy obtainable from the practical application of Bjerknes's theorem to the sea than the close agreement between Wüst's calculations (1924) and Pillsbury's measurements (1889) for the Florida Current, and the measure of agreement between the movements of Atlantic icebergs and the calculations of the Ice-Patrol. The same section gives the first publicity, outside enemy countries, to a new method of finding a suitable reference surface for the application of the theorem, first described by Defant in a German Atlantic Expedition report in 1941. It assumes that the surface of no motion lies in the depth interval within which the spacing of the isobaric surfaces remains more or less the same between adjoining stations. A certain amount of trial and error is necessary to find a continuous surface over a network of stations, but the method as used by Defant for the Atlantic Ocean gave results in good agreement with the best independent evidence. It has since been used in the Black Sea[1], and it will be tried extensively for other regions after the War.

From the section on tides and internal waves, it is clear that there can be large horizontal water-velocities at great depths. A mechanism exists which tends to sweep all fine material from peaks and ridges, to be deposited at greater depths. The absolute depth of the peak appears to be of no consequence; the sweeping is likely to be effective when the peak rises 500 metres above its surroundings, whether from 1,000 or 5,000 metres.

The longest chapter (157 pages) gives an excellent summary of the water masses and currents in all parts of the world. Arguing that it is rational to deal first with the simpler conditions, and gradually to enter upon the more complicated, the authors begin their survey with an account of the water circulation of the Southern Ocean, which is shown to be a very good field for oceanographical research.

Other long sections deal with the chemistry of sea water, waves and tides, marine sedimentation, organic production in the sea, the methods of making observations and collecting and the role of bacteria in the sea. The heat budgets of the oceans, differences in the balance between incoming and outgoing radiation and between evaporation and precipitation are closely considered; and throughout the book emphasis is given to the inter-relations between the oceans and the atmosphere. It is difficult to convey a true impression of the great wealth of information contained in the book. It is never likely to fail as a reference book, and it will be the starting point of many inquiries; foreseeing this, the authors have, when possible, referred to books containing comprehensive bibliographies rather than to original papers.

There are a few printer's errors, though none likely to cause serious misapprehension. It may be worth mentioning that the tonnage of the R.R.S. *Discovery II*, quoted in Table 57, should be 1,200 tons displacement, not 2,100; and the constant at the foot of page 1,051 should be 0·02736, not 0·02763. It should also be noted that it is now common usage in English to refer to the periodical water movements accompanying the tides as tidal *streams*, keeping *currents* for the non-periodical movements due to other causes such as prevailing winds and density differences.

Of the thousand references at the ends of the chapters, half refer to American publications, a sixth to British and a sixth to German. The figures are an approximate measure of the relative efforts made in the three countries. They do not, however, reflect the importance which has been attached to oceanographical research in the Soviet Union and in Japan, probably because of the language difficulties. The Soviet Government is producing its own manual, which is likely to be the only rival to the American book for very many years. It will be a much larger

work when completed, and a glance at the first volume, although I have been unable to read it, suggests that it is more encyclopædic—mentioning almost everything that has been done.

"The Oceans" will appeal to many seafarers; many ships would be glad to have a copy. There is no doubt that it will be very effective in promoting research, and increasing our knowledge of the oceans.

G. E. R. DEACON.

[1] "Die absolute Topographie des physikalischen Meeresniveaus und die Oberflächenströmungen des Schwarzen Meeres". By G. Neumann. *Ann. Hydrog. und Mar. Meteorol.*, 70, ix (1942).

BIRDS OF THE SOUTH-WEST PACIFIC

Birds of the South-West Pacific

A Field Guide to the Birds of the Area between Samoa, New Caledonia and Micronesia. By Ernst Mayr. Pp. xx+316+3 plates. (New York: The Macmillan Company, 1945.) 3.75 dollars.

AFTER the American Forces commenced operations among the Pacific Islands, the American Museum of Natural History was inundated with requests for a book on the birds of the region. There was, however, no work on the whole area published, although many papers had been written on the birds of the different groups of islands. Fortunately, a member of the staff had already made a special study of the species found in the Pacific and neighbouring areas. This was Dr. Ernst Mayr, and no one was more competent to write the present volume, since, in addition to his systematic studies, he has spent several years in New Guinea, the Bismarck Archipelago and the Solomon Islands, and accordingly was familiar with many species in the field. The area covered by this volume comprises the groups of islands from Tonga in the south to the Mariana Islands in the north, and west as far as the Solomons.

In the introduction the author gives lucid hints on how to identify birds; he points out that though there may still be a few undetermined species in the mountains of the Solomons or in New Ireland, there remains much to learn of the life-histories and habits of nearly every bird.

The volume is divided into two parts: a general survey of the species, and more detailed lists of those found in the different groups of islands. In the first part, the birds are divided into groups, the sea-birds, shore-birds, and land- and freshwater-birds. Of the sea-birds, the terns are by far the most numerous and embrace thirteen different species, but only one gull, the Australian silver-billed gull, occurs in the area. On the other hand, the petrels, ranging in size from the wandering albatross to a Mother Carey's chicken, though much fewer in numbers, are represented by more than twice as many species. The other sea-birds are the frigate and tropic birds and the widely spread boobies. With the exception of the Australian stilt, all the shore-birds are migrants from the north. Several, including the common sandpiper, turnstone and sanderling, are familiar summer and winter visitors to the British Isles. The remaining section embraces a great diversity of types: cassowaries, grebes, ducks, hornbills, sun-birds, honey-eaters and others, as well as several introduced species, namely, the Indian myna, Malay turtle dove and red-browed waxbill.

The second part gives additional details of the land- and freshwater-birds inhabiting the different groups of islands, and here the observer will discover how little is known of the habits of many species. In some of the archipelagos certain birds, such as flycatchers, whistlers (*Pachycephala*), white-eyes and honey-eaters, tend to vary and divide up into races on the different islands. Dr. Mayr does not go into details on this point, but gives just sufficient particulars to recognize the races. This area is the headquarters of the brilliantly coloured fruit pigeons which combine such a wonderful variety of tints, and New Caledonia is the home of the flightless kagu, which is now in danger of extermination since it falls an easy prey to prowling native dogs. The gems of the parrot-world, the tiny pygmy parrots, no more than 3½ in. long, are found in the Solomons; they bore holes in the nests of tree-haunting termites where they deposit their eggs. They are reported to feed on their hosts or possibly fungi.

There is a map on the inside of the cover, three coloured plates and sixteen line drawings which will facilitate the naming of species.

Dr. Mayr is to be congratulated on the production of this small work at such short notice, and there is no doubt it will be welcomed by the troops in the Pacific.

ELEMENTARY ZOOLOGY

A Manual of Elementary Zoology

By Dr. L. A. Borradaile. (Oxford Medical Publications.) Eleventh edition. Pp. xiii+813. (London, New York and Toronto: Oxford University Press, 1945.) 24*s*. net.

THE first edition of "Borradaile" appeared in 1912 and the second only in 1918. The slow start was no doubt due to the first World War; it is interesting to compare the book's record in the second. At some time in 1939 there was a second impression of the ninth edition, then came the tenth edition in 1941, its second impression in 1943, and now the eleventh edition in 1945. One wonders how many students this very valuable book has helped through the bewilderment of their first contact with zoological facts and ideas, and how many professional zoologists it has extricated from class-room and other difficulties. The publishers do not announce their sales, but they must now be very many thousands.

The new edition continues the book's development. There is increased attention to problems of function, reducing the force of the criticism made by some that the book devotes to these subjects less attention than is due even in an elementary text. In addition, there are some important changes in the chapter of embryology, where the development of *Amphioxus* is now based on Conklin's description. The account of gastrulation in the chick is the classical story of delamination, but more recent views are mentioned. The sections on genetics are somewhat expanded, with some discussion of mutation and recombination, and there are new diagrams of meiosis and crossing over. A new passage which should stir the interest of any intelligent student is that on the "History of the Vertebrata" in Chapter 22. Altogether, there are some fifty new figures.

The value of the book is proved by the number of its editions and reprintings; it is to be hoped that many more lie in the future.

P. D. F. MURRAY.

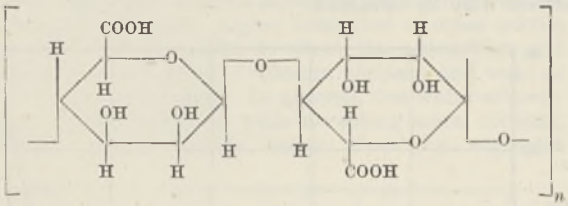
SEAWEED RAYON

By PROF. J. B. SPEAKMAN

Textile Chemistry Laboratory, University of Leeds

DRY seaweed contains 15–40 per cent of alginic acid[1], which is readily extracted with sodium carbonate solution[2]. Sodium alginate was available in powder form before the War, but no serious attempt had been made to examine its possibilities as a raw material for the manufacture of rayon, despite the existence of abundant supplies of seaweed off the west coasts of Scotland and Ireland, and the ease with which filaments are obtained when a solution of sodium alginate is extruded into baths containing inorganic acid or a salt of a suitable polyvalent metal. Unfortunately, these favourable characteristics were overshadowed in the minds of early observers by the fact that the salts of alginic acid—or such of them as were examined—were found to be soluble in solutions of soap and soda. There seemed to be little purpose in devising satisfactory methods of spinning alginate rayons when the fabrics made therefrom would dissolve in the solutions commonly used in laundering textile materials. Furthermore, the prospect of producing alkali-resistant alginate rayons must have seemed remote in the absence of exact information about the constitution of alginic acid.

Alginic acid was recognized as a polymer of *d*-mannuronic acid in 1930[3], but the precise mode of polymerization has since been the subject of much discussion. In the light of recent determinations of the equivalent weight[4], the simple preparation of the di-acetyl derivative[5], and an X-ray examination of well-oriented alginic acid filaments[6], there can now be little doubt about the correctness of the constitution proposed by Lunde, Heen and Öy[1], supported by Hirst, Jones and Jones[7] [see also p. 667], namely :



The molecular weight of the polymer is high, but varies with the mode of isolation : osmotic pressure determinations on a series of sodium alginates, dissolved in 0·2 *N* sodium chloride solution, gave values ranging from 48,000 to 185,000[8]. All such alginates should clearly be capable of successful use in the production of rayon, especially as the viscosity of relatively dilute solutions is great enough to permit successful spinning on the viscose system. In the early years of the War, therefore, when it seemed essential to make the fullest possible use in Britain of home-produced raw materials, the possibility of making rayon from seaweed was investigated.

Although the main purpose of the work was the production of alkali-resistant alginate rayon, the general problems involved in spinning satisfactory yarn from sodium alginate—satisfactory in appearance, feel and strength—were first investigated[4] in two simple cases, namely, the spinning of calcium alginate and alginic acid yarns, both of which are soluble in sodium carbonate solution. The equipment used was similar to that employed in spinning viscose rayon. A 5 per cent solution of sodium alginate was forced through a candle filter to a gear-wheel pump, which delivered the solution to a tantalum spinnerette immersed in a bath of acidified calcium chloride. In the preliminary experiments the spinnerette had twenty-one 0·1 mm. holes, and the resulting 21-filament yarn was drawn off by a glass revolving godet from which it passed through a traversing funnel into a Topham box revolving at 3,000 r.p.m. Here the yarn was collected in cake form. It was then washed, reeled into hanks and dried.

As produced in this way, the yarn was useless as a textile material : its handle was harsh and straw-like because the component filaments, which are highly swollen when first spun, adhere to one another during drying. The difficulty was overcome by extruding sodium alginate solution into a coagulating bath containing emulsified oil[9], the filaments being thus coated with a film of oil which prevents adhesion. Although greatly improved, the handle and appearance of the resulting yarn were still unsatisfactory, owing to the irregular ribbon-like form of each filament. It was then found that the cross-section of the filaments became more and more nearly circular as the concentration of sodium alginate in the spinning solution was increased. Yarn of excellent handle and appearance was finally obtained by extruding a 7·5–8·0 per cent (w/w) solution of sodium alginate into a coagulating bath containing calcium chloride (1·0 *N*), hydrochloric acid (0·02 *N*) and 2·5 per cent by volume of olive oil emulsified with a neutral detergent such as 'Lissapol C' (I.C.I.). The tenacity of the yarn was, however, rather low, being no more than 1·23 gm./denier* at 64·8 per cent relative humidity, compared with values of about 1·3 and 1·8 gm./denier for cellulose acetate and viscose rayons, respectively. The weakness of the calcium alginate rayon was ultimately traced to two causes : degradation by acid carried over from the coagulating bath during the time the cake is being spun, and mechanical damage to the freshly spun, swollen filaments when the yarn is reeled into hank form for drying. The first difficulty was overcome by washing the yarn as its traversed the godet on its way to the Topham box ; and the second by leading the yarn from the cake through running water, then through a dryer, and winding directly on to bobbins. With these refinements, no difficulty was encountered in producing yarns with a tenacity of 1·8–2·1 gm./denier at 64·8 per cent relative humidity.

Attention was next turned to alginic acid rayon, which is more difficult to spin because, in the absence of metal-containing cross-linkages, the filaments are weak and highly swollen. To prevent filament adhesion during drying, it was found necessary to emulsify the oil in the coagulating bath with a cation-active agent, such as 'Fixanol' (I.C.I.), which is adsorbed by the filaments. Good results were obtained by extruding sodium alginate solution into a coagulating bath containing sulphuric acid (1·0 *N*) saturated with sodium sulphate and 2·5 per cent by volume of olive oil emulsified with 1 per cent (w/v) of 'Fixanol'.

It is, however, unlikely that alginic acid yarn will ever be produced on the large scale because of the rapidity with which it undergoes degradation during storage. Even when kept in the dark at 65 per cent relative humidity and 22·2° C., the tenacity of a well-washed alginic acid yarn fell from 1·06 gm./denier after 28 days to 0·36 gm./denier after 480 days[10].

* The denier of a yarn is the weight in grams of 9,000 metres.

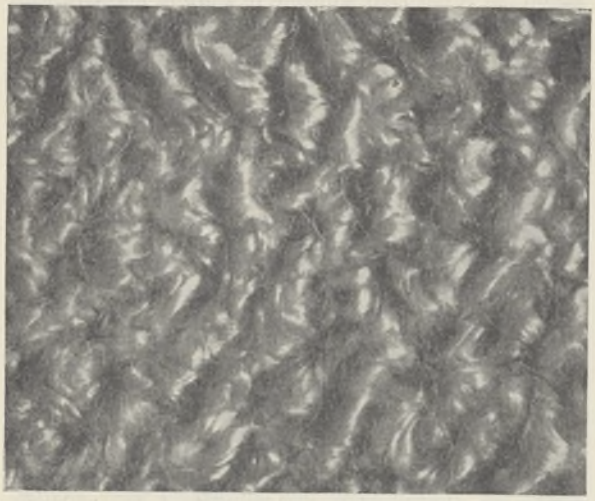


Fig. 1.

Well-washed calcium alginate yarn, on the other hand, can be stored for periods up to at least thirty weeks without significant loss of strength, and can be converted into alginic acid yarn, whenever necessary, by mere washing with cold, dilute hydrochloric acid.

As soon as satisfactory methods of spinning alginate rayons had been devised, the possibility of producing alkali-resistant rayons was investigated. It seemed likely that success might be achieved by cross-linking alginic acid with metals of high co-ordinating power, such as chromium[11] and beryllium[12], instead of with calcium. When, however, sodium alginate solution was extruded into baths containing chrome alum and beryllium sulphate, the resulting yarns were harsh, wiry and brittle, despite the presence of emulsified oil and cation-active agents in the coagulating baths[4]. Direct spinning of chromium and beryllium alginate rayons was found to be impossible, but when calcium alginate rayon was treated with a 2 per cent solution of one-third basic chromium acetate[13] at 25° C., calcium was displaced by chromium. The extent of displacement increased with increasing time of treatment, but yarn containing as little as 1·29 per cent chromium, while retaining 9·04 per cent calcium, was undissolved after immersion for twenty-four hours in a solution of soap and soda at room temperature. Similarly, a yarn containing 2·89 per cent beryllium and 5·20 per cent calcium, prepared by treating calcium alginate rayon with a 2 per cent solution of basic beryllium acetate[4] at room temperature, was found to be alkali-resistant. In both cases, the stability of the yarns appears to be due to co-ordination of the metal—chromium or beryllium—with the hydroxyl groups of alginic acid.

Still better yarns were obtained—better in being free from calcium—by treating alginic acid yarn, derived from calcium alginate yarn, with the basic acetates of the metals. Prepared in this way, both chromium and beryllium alginate rayons suffer less than 5 per cent loss in tenacity on treatment with a solution of soap and soda for thirty minutes at 25° C. or 40° C., and the beryllium alginate rayon, which is more useful in being uncoloured, has a tenacity of more than 2·0 gm./denier.

Alkali-resistant rayon can also be obtained by cross-linking alginic acid yarn with formaldehyde[14] instead of co-ordinating metals. Cross-linking is brought about by impregnating the yarn with a solution of ammonium chloride and formaldehyde at *p*H 3, and then drying at 95° C. As the carboxyl groups of the treated filaments are free, the yarn, though undissolved, is swollen by alkalis, but swelling can be restricted by further treatment with the basic acetates of chromium and beryllium.

Ultimately, therefore, the basis of all the alkali-resistant seaweed rayons is calcium alginate rayon, which is cheap and easily spun, and possesses satisfactory elastic properties for weaving and knitting. For these reasons it seems likely that calcium alginate rayon will form the stock material for all purposes: for conversion into woven and knitted fabrics, which can be made alkali-resistant in finishing, as well as for special uses in which advantage is taken of its solubility in alkalis. These special uses[15], which are now so numerous as to make the alkali-soluble rayon as important as the alkali-resistant varieties, were developed in the belief that a defect can always be turned to advantage. Two illustrations will perhaps serve to indicate the power which has thus been placed in the hands of the textile designer. When a fabric is woven from yarn prepared by twisting together cotton and calcium alginate yarns in such a way as exactly to remove the twist from the cotton yarn, subsequent scouring leaves a cotton fabric composed of yarns entirely without twist; fabrics of this type have already found a number of important practical applications. Secondly, if a fabric is woven from yarns prepared by twisting together mohair and calcium alginate yarns in such a way as to persuade the mohair to wrap around the alginate, the extra length of mohair is released to form loops on the surface of the cloth, as shown in Fig. 1, when the fabric is scoured in a solution of soap and soda. The 'disappearing fibre' technique has, in fact, simplified the methods of manufacture of a large number of fabrics, besides indicating how a number of new effects may be obtained.

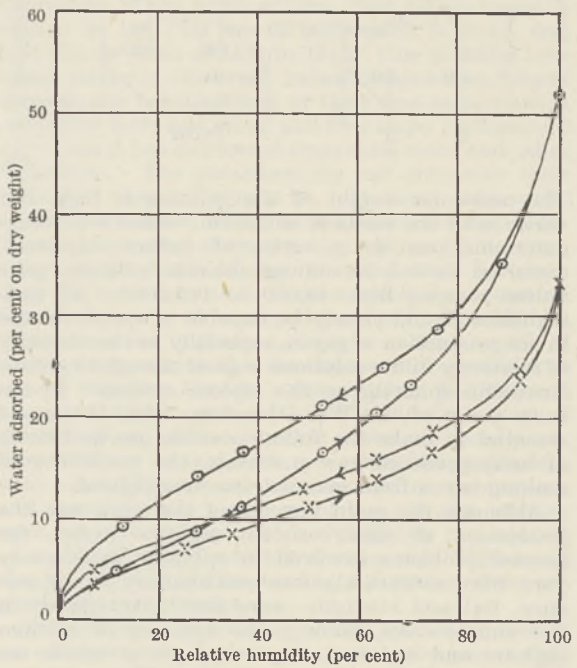


Fig. 2.

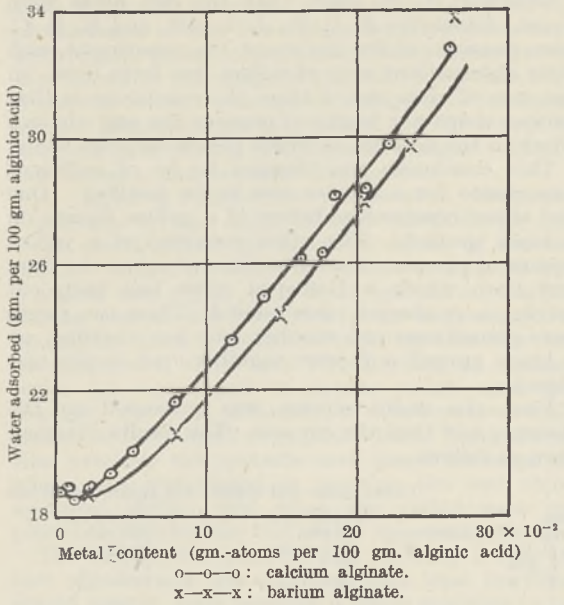


Fig. 3.

In view of the importance of calcium alginate rayon, its properties have been examined in greater detail than those of other alginates. The yarn has a relatively high tenacity, varying from 1·8 to 2·1 gm./denier, with an extension at break of about 20 per cent at 64·8 per cent relative humidity. Because of its high metal content (about 10·4 per cent), calcium alginate has the rather high density of 1·78 when dry, but the presence of the metal has the great advantage of making the material totally non-inflammable, a property which is shared by other metal alginates. All the alginates have a high water-adsorption capacity, higher than that of other textile fibres, as shown in Fig. 2, where the adsorption and desorption isotherms of calcium alginate and wool at 25° C. are reproduced. In general, the water-adsorption capacity increases with increasing metal content, closely related results being given by alginates derived from metals in the same group of the Periodic Table. This interesting observation is illustrated by the curves of Fig. 3, where the amounts of water adsorbed by a series of calcium and barium alginates at 64·8 per cent relative humidity and 22·2° C. are shown as a function of the metal content. As would be expected, too, the breaking load of calcium alginate yarns increases with increasing metal content, on account of the increasing number of cross-linkages between the chain molecules; but since the density of the yarn also increases, there is an optimum metal content for maximum tenacity (gm./denier) as shown in Fig. 4.

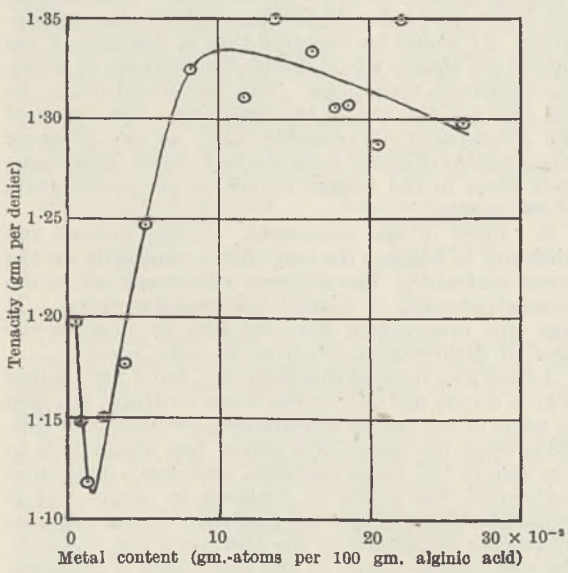


Fig. 4.

Alginate rayons have a marked affinity for basic dyes. In addition, they can be dyed with selected direct dyes and, when the yarns contain chromium or beryllium, with mordant dyes. There is, therefore, good reason to believe that the seaweed rayons will find an important place in the textile industry of the future.

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THE CHANGE FROM TRICHROMATIC TO DICHROMATIC VISION IN THE HUMAN RETINA

By Prof. H. HARTRIDGE, F.R.S.

MANY years ago I noticed the confusion of yellow with white, and blue with black when test objects of small size are under critical examination[1]. I thought, incorrectly, that this confusion was due to the chromatic aberration of the eye. Some years previously, König had, unknown to me, given the true explanation of the phenomenon, namely, that for objects of small size, examined by the fovea centralis, trichromatic vision is replaced by dichromatic vision[2]. He thought that this change was strictly limited to the fovea centralis. Recently Willmer has come to the same conclusion[3]. Both König and Willmer are mistaken, however, for in a recent communication in *Nature*, I have produced evidence that the change occurs not only at the fovea centralis but practically all over the useful retina[4]. Further evidence on this point has now been obtained, together with many other facts, concerning the appearance of the colours of very small objects.

1. *Effect of angle of view.* Before beginning this section it is necessary to point out the difference between angle of view and visual angle. By the former is meant the angle between the fixation axis and the line joining the centre of the test object with the eye. By the latter is meant the angle between

the lines joining the edges of the test object with the eye. Thus when the centre of the image of the test object falls on the fovea centralis, the angle of view is zero. When, however, the observer directs his gaze more and more to one side of the test object, the angle of view increases in value, while the visual angle stays constant.

During the tests on the effect of angle of view, a yellow test object, 6 mm. square, was viewed on a black ground in daylight. Four small blue-green fixation marks were placed on the background with their centres 4, 8, 12 and 16 cm. below the centre of the test object. Each observer determined (1) the distance at which the test object was definitely yellow, (2) the distance at which it appeared to be white, (3) the distance at which the transition from yellow to white occurred. The observer fixated the test object or one of the blue-green fixation marks as might be required. The results are shown in the following table:

	Fixation at 0	4	8	12	16 cm.
H. H.					
1	6·5 metres	8·5 metres	12·0 metres	23·0 metres	12·0 metres
2	11·0 ,,	11·5 ,,	19·5 ,,	27·0 ,,	25·0 ,,
3	9·0 ,,	9·5 ,,	16·0 ,,	24·5 ,,	21·0 ,,
J. L. d'S.					
1	18·5 ,,	22·0 ,,	27·0 ,,	16·5 ,,	15·0 ,,
2	24·0 ,,	28·5 ,,	34·0 ,,	24·0 ,,	23·0 ,,
3	22·5 ,,	25·0 ,,	31·0 ,,	20·0 ,,	20·0 ,,
E. C. T.					
1	16·0 ,,	13·0 ,,	11·0 ,,	13·5 ,,	12·0 ,,
2	21·5 ,,	21·0 ,,	19·0 ,,	18·5 ,,	18·0 ,,
3	18·5 ,,	18·0 ,,	16·0 ,,	16·0 ,,	16·0 ,,
G. N. J.					
1	5·5 ,,	8·5 ,,	7·5 ,,	9·5 ,,	10·5 ,,
2	10·5 ,,	12·0 ,,	12·0 ,,	14·0 ,,	14·0 ,,
3	8·0 ,,	10·0 ,,	12·0 ,,	13·0 ,,	13·0 ,,

The above table brings out two points: that the transition from yellow to white occurs at peripheral parts of the retina just as it does at central parts, and that considerable variations in detail occur between different observers.

I have assumed that the transition from yellow to white indicates that trichromatic vision has been replaced by dichromatic vision. Evidence on this point will be found in Section 13 of this article. On the assumption that this evidence is acceptable, the following statement can be made. For test objects of average size the colour vision of normal persons is approximately trichromatic, while for test objects of sufficiently small size, colour vision is nearly dichromatic (see Section 14). The transition occurs at a given distance from the eye for a particular size of test object which depends on several factors. Two of these are shown in this section to be the observer, and the angle of view.

2. *Importance of area of test object.* The distance between object and observer at which the transition from yellow to white takes place might depend, for example, on the area of retina which is being stimulated, or on the quantity of light which is falling on the retina, or on the length of contour of the test object. Various tests were carried out on these lines, and area was found to be an important factor. In the following table the distances are recorded at which two yellow test objects of the same area but of different shape were found to become white.

	Square test object	Oblong test object
Length	12 mm.	6 mm.
Width	12 ,,	24 ,,
Length of contour	48 ,,	60 ,,
E. C. T.	28·5 metres	26·5 metres
J. L. d'S.	28·0 ,,	25·5 ,,
E. B. C.	26·0 ,,	27·0 ,,
H. H.	16·0 ,,	18·0 ,,

Observer H. H. knew that the two areas were equal. Observers E. C. T., J. L. d'S. and E. B. C. were unaware of the nature of the experiment, and their observations were therefore free from bias. In the case of each one of them the conclusion is that neither shape nor length of contour has any obvious effect on the distance at which yellow becomes white.

This conclusion was deemed to be of sufficient importance for a further test to be justified. One test object consisted as before of a yellow square on a black ground. The other consisted of a yellow square of precisely the same dimensions as the first, and from which a U-shaped piece had been cut leaving a ⊓-shaped piece behind. These two pieces were placed near one another, but not touching, on a black ground and were together used as the test object.

First the uncut square was presented to the observer and then the cut one. The results obtained were as follows:

	Uncut square test object	Cut square test object
Area	144 sq. mm.	144 sq. mm.
Length of contour	48 mm.	128 mm.
E. B. C.	20·5 metres	19·5 metres
J. L. d'S.	25·7 ,,	27·7 ,,
E. C. T.	28·7 ,,	29·3 ,,

In this case also, the differences in distance are small and within the probable experimental error; so that in spite of the great difference in the shape and in the length of contour of the two test objects, they change colour at the same distance from the eye.

These tests show that neither shape nor length of contour are important factors in determining the distance at which the change from yellow to white takes place.

Further evidence on this point will be found in Section 10.

That alteration in size greatly affects the distance in metres at which the transition from yellow to white takes place is shown in the following table:

Size	J. L. d'S.	G. W. J.	H. H.	E. C. T.	J. E. T.	Mean
6 mm.	6·1	8·0	9·3	10·7	13·5	9·9 } metres
12 ,,	11·8	10·1	17·7	17·7	18·8	15·2 } metres
24 ,,	19·3	20·3	30·0	25·3	23·3	23·6 } metres

All these test objects were yellow squares on a black ground; one had 6-mm. sides, whereas the other two had sides of 12 mm. and 24 mm. respectively. It would be expected that a doubling of the side of the square would double the distance at which the transition took place. This was found not to be the case for any one of the observers. The cause of the discrepancy is probably that, as the observer increased his distance from the test object, alterations took place in the images falling on peripheral parts of the retina.

3. *Effect of eye movements.* König noticed the difficulty of holding the test object constantly on the fovea centralis[2]. The slightest movement led to the re-establishment of normal trichromatic vision. It was this observation that led him to suppose the area of dichromatic vision to be very small.

I have also noticed this difficulty, but I have found that it occurs not only in the fovea centralis, but also in parts of the retina considerably peripheral to this. Thus when the image of a yellow test object falls to one side of the fovea centralis, and exact fixation is performed, the yellow is replaced by white and it remains white during exact fixation. On the slightest movement performed by the observer's eye, however, the true yellow colour of the test object is moment-

arily disclosed to view. The explanation of this phenomenon is that the change from trichromatic to dichromatic vision occurs locally, being limited to the area on which the image of the test object falls; but if the test object be moved, or the eye axis be altered, a fresh area of retina is involved and for a moment it reacts in a normal trichromatic manner. Then it too changes, and becomes dichromatic.

4. *Effect of simultaneous presentation.* From past experience it was expected that simultaneous contrast would affect the apparent colour of the test object. Thus if an observer stood at a distance from a yellow test object on a black ground so that the former was at the transition point between yellow and white, then it would be expected that the close proximity of a white area would, owing to contrast, cause the test object to appear yellow, and that similarly the close proximity of a yellow area would cause the test object to appear white. Tests showed that precisely the opposite took place, for when the white area was placed in position the test object appeared white; and when the yellow area was placed in position the test object appeared yellow.

The cause of this phenomenon probably is that the test object, and the coloured area that has been placed near it, form together a single stimulus to the retina, and their combined areas are taken into account when determining whether or not the change from trichromatic vision to dichromatic vision shall occur (see Section 10). Thus a single yellow test object may be viewed at such a distance that it has the appearance of being white; but, on placing a second yellow test object close to it, it immediately reverts to yellow. One test object alone is so small that trichromatic vision is replaced by dichromatic vision. When, however, there are two such objects in the visual field, their combined areas may be too large for dichromatic vision to be possible, and in consequence there is a return to trichromatic vision.

5. *Spatial effect.* It has been shown in the previous section that the close proximity of a yellow area biases the test object towards yellowness, and that similarly a white area biases it towards whiteness. In this section the effect of distance between the test object and the coloured 'biasing' area will be dealt with.

The test object was a yellow square with 12 mm. sides. The 'biasing' area was a yellow rectangle 100 mm. high and 25 mm. wide. This was placed at various distances from, and to the left-hand side of, the test object. On the other side of the test object was a white 'comparison' area 100 mm. high and 25 mm. wide. This was placed at a constant distance of 20 cm. from, and to the right-hand side of, the test object. The results obtained were as follows:

Distance between test object and 'biasing' area	Distance for test object to appear white
Infinity	8·8 metres
20 cm.	12·5 ,,
10 ,,	18·5 ,,
5 ,,	23·0 ,,
0·5 ,,	38·0 ,,

It will be seen that as the distance between the 'biasing' area and the test object is reduced, the greater the distance becomes at which the test object appears white.

6. *Overlap.* On numerous occasions it has been noticed that the change from trichromatic to dichromatic vision does not occur sharply, nor does it always occur when the test object is at the same distance from the observer. Sometimes the phenomenon of overlap is observed. The change from yellow to white may occur at a considerably greater distance between test object and observer than the reverse change from white to yellow. Overlap is more likely to be observed when very careful fixation is being preserved, for the slightest eye movement reduces it considerably. It is as if the mechanism causing the change in vision suffered from backlash, and that small eye movements have the effect of reducing this.

7. *Effect of brightness of illumination of the test object.* Unfortunately, it has not been possible owing to war conditions to perform any precise measurements on the effect of illumination on the change from trichromatic to dichromatic vision. On a number of occasions, however, tests have been made to see if the intensity of illumination of the test object plays an important part. The reason for making these tests is that since the change-over depends on the area of the test object, and not on its shape (see Section 2), it might be that the total amount of light reaching the retina is really the determining factor; in other words, the product of area and illumination, allowance being made for any variations in the diameter of the pupil. Illuminations of 1–3,000 ft. candles approximately have been tested, using an artificial pupil of 1·5 mm. There is no doubt that light intensity plays some part as the following values show:

A yellow test object 6 mm. square changed to white at following distances.

1 ft. c.	12 ft. c.	100 ft. c.	3000 ft. c.
1·7 metres	3 metres	8 metres	18 metres

Illumination does not play the important part, however, which it would do if total light reaching the retina was the criterion. For change in illumination of 1 to 3,000 ft. c. would then be accompanied by a change of distance in the ratio of 1 to 55. Change in the degree of light adaptation may well have taken place in the above experiments. The possible effect of this will now be explored.

8. *Effect of adaptation.* The effect of adaptation on the distance at which a yellow test object becomes white has been tested by taking two adaptation levels: light adaptation by gazing for 1 min. at the sky, and dark adaptation by excluding light from the eyes for 5 min. It was realized that neither full light adaptation nor full dark adaptation would be obtained in such short times. The object of this experiment was to ascertain if adaptation produced a noticeable change in the distance at which the test object changed colour.

The result obtained was far from satisfactory. On some occasions light adaptation seemed to increase the distance, whereas on others it seemed to produce no effect or even a slight decrease. On the whole, some increase of distance seems to be produced, but the effect is not a marked one. It might account in part, however, for the increase in distance with illumination noted in the previous section.

9. *Effect of depth of tint of test object.* If several yellow test objects of the same shape and size, but of different depth of tint, be tested as before, it will be found that very obvious variations occur in the distances from the observer at which they become a neutral tint: white in the case of the paler shades of yellow, but grey in the case of the darker shades. The following example is typical of the results obtained:

Colour of test object	Distance in metres
Pale lemon yellow	12·5
Daffodil yellow	18·0
Chrome yellow	27·0

As might be expected, a deep tint requires a greater distance than a pale one, since in the latter case the colour is already diluted with white light.

10. *Effect of the shape of the test object.* Two experiments have been described in Section 2 in support of the statement that it is area and not shape which determines the distance at which a yellow test object changes to white. It is, however, only necessary to take an extreme case to see that this cannot always be the case. Suppose, for example, that the whole or an important part of the image fell on the blind spot; then that part, at all events, would contribute little if at all to the stimulation of the retina. It is possible also that parts of the test object falling outside the fovea will have a significantly different effect from those parts which fall inside it. To test this possibility two test objects were compared. One as before consisted of a yellow square with 12 mm. sides, the other consisted of a similar square which had been divided into nine squares each with 4 mm. sides. One of these squares, which was used as the fixation point, was mounted on the centre of a black ground, the others were mounted in a ring of 10 cm. radius around the central one to form a star. The following distances were obtained:

		Square test object (area, 144 sq. mm.)	Star test object (area, 144 sq. mm.)
G. N. J.	yellow at	8·5	5·5
	white at	12·2	12·0
	mean	10·4	8·8
H. H.	yellow at	11·6	6·6
	white at	15·0	11·5
	mean	13·3	9·0
J. L. d'S.	yellow at	17·7	15·0
	white at	23·7	21·7
	mean	20·7	18·4
E. C. T.	yellow at	7·0	7·5
	white at	16·0	15·0
	mean	11·5	11·3

All four observers found that a somewhat greater distance was required for the square than for the star. In the case of any one observer, the differences are probably within the experimental error; but since all four observers found the differences in the same direction, I think they are significant. It is not, however, the magnitude of these differences which I wish to emphasize, but on the contrary their smallness. They indicate the apparently extraordinary facility with which the retina integrates the various parts of a pattern so as to ascertain the total area.

Until further experiments have been performed the following provisional statement may be made: provided that no part of a pattern falls on the blind spot or on some other defective area of the retina, and provided that the parts of a pattern are not too widely separated, the retina integrates the various parts of the pattern so as to arrive at the total area.

11. *Effect of pupil diameter.* Artificial pupils were used to reduce the aperture of the eye to the required size, and the effect on the distances at which a yellow test object on a black ground became white were determined.

Pupil diameter	Illumination rates	Distance at which yellow becomes white
5·7 mm.	32·5	15·0 metres
4·8 ,,	23·0	10·5 ,,
4·0 ,,	16·0	9·1 ,,
3·2 ,,	10·2	8·6 ,,
2·4 ,,	5·8	7·5 ,,
1·6 ,,	2·6	6·2 ,,
1·0 ,,	1·0	5·0 ,,

As the aperture of the eye is reduced in size, the distance from the observer to the test object becomes less. Now a reduction in aperture is accompanied by a reduction in the light intensity reaching the retina; and, as seen in Section 7, the latter is accompanied by a decrease in the distance at which yellow becomes white. In Section 7 it was found that an increase in illumination from 1 ft. c. to 100 ft. c. required an increase in distance from 1·7 to 8 metres, that is by 4·7 times. This increase corresponds reasonably well with that given by the change in pupil diameter. As suggested in Section 8, the effect of change of illumination may be due to a change in retinal adaptation. It is possible that the effect of change of pupil diameter here recorded may have a similar cause.

12. *Effect of colour of the background.* It seemed likely that a yellow test object on a blue ground would tend to retain its colour more readily than one on a black ground, because the blue ground would enhance the yellow colour by simultaneous contrast. Experiments showed that the exact opposite is the case, as the following results show:

Colour of background	Distance at which yellow becomes white
Black	17·4 metres
Blue	9·3 ,,

The explanation given previously appears to be correct, namely, that the chromatic aberration of the eye causes the blue ground to overlay the yellow test object and therefore to reduce its yellowness, since blue and yellow are complementary in colour to one another[7]. The following observations support this conclusion. The effect of pupil diameter on the distance at which a yellow test object on a blue ground becomes white is shown in the table below:

Pupil diameter	Distance at which yellow becomes white on blue ground	on black ground
5·7 mm.	8·3 metres	15·0 metres
4·8 ,,	8·5 ,,	10·5 ,,
4·0 ,,	8·6 ,,	9·1 ,,
3·2 ,,	8·0 ,,	8·6 ,,
2·8 ,,	7·3 ,,	—
2·4 ,,	6·0 ,,	7·5 ,,
2·0 ,,	6·5 ,,	—
1·6 ,,	5·6 ,,	6·2 ,,
1·3 ,,	5·2 ,,	—
1·0 ,,	5·0 ,,	5·0 ,,

If the values in the second column be compared with those given in the previous section, which are repeated in the third column above, it will be seen that with large pupils the substitution of the blue ground for the black one greatly reduces the distance at which yellow becomes white; but that as the pupil is reduced in size, the difference gets less and less until at 1 mm. aperture the difference disappears entirely. The explanation is as follows. With large pupils the effect of chromatic aberration is considerable, and since blue rays come to a different focus from yellow rays, the latter are mixed with the former to produce white, when a yellow test object lies on a blue ground. This is not the case, however, when a yellow test object lies on a black one. Consequently, the latter requires a greater distance for yellow to become white than does the former. With small pupils, on the contrary, the effect of chromatic aberration is small; so that scarcely any mixing of test object with background takes place. In consequence, the substitution of a blue ground for a black one has scarcely any effect on the distance at which the yellow test object becomes white.

13. *Effect of the colour of the test object.* In previous sections the experiments described have been limited to yellow test objects, because it was considered better to concentrate on one colour rather

than to describe the use of one colour for one test and another colour for a different test. The main conclusions reached with yellow have, however, been tested with other colours, namely, green, blue, purple and crimson. Green on a black ground both at the fovea and the periphery becomes blue-green, and so does blue. Purple becomes reddish-brown, and crimson becomes orange. In no case has an observation been made which would lead to the conclusion that the change, either at the fovea centralis or at the more peripheral parts of the retina, is not one of dichromatism of the type described previously. Therefore, so far as is known at present, all the experiments described using a yellow test object could be done equally well, and with a similar result, with a test object of any of the other colours mentioned above.

14. *Nature of the dichromatism.* When studying the changes in colour which take place when very small test objects are looked at, three unexpected observations were made :

(1) The short-wave end of the spectrum was expected to be blue-green, precisely complementary to red. It seemed, however, to be too blue for this to be the case.

(2) Instead of orange appearing to be red diluted with white, as would be the case if true dichromatic vision was present in the retina, it was found that orange retained its natural colour.

(3) It was observed that crimson, which was expected to become some shade of red mixed with white, actually became orange.

All the above anomalies obviously require explaining. In the first place, an explanation was sought on Young's theory of trichromatic vision without a satisfactory result, so that an alternative explanation was sought for. This was obtained on the basis of Granit's results with mammalian retinas using micro electrodes[5].

Granit, in a private communication, has informed me that he has obtained evidence of seven varieties of modulator in the mammalian retina : two red ones at 600 λ (common) and at 580 λ (less common) ; three green ones at 540 λ, at 520 λ, and at 500 λ ; and two blue ones at 460 λ and at 330 λ.

Now if the dichromatism left unchanged the two red receptors at 600 λ and 580 λ, but converted all the remainder except the blue ones into a single sensation, then a modified form of trichromatic vision would result, namely : red due to the sense organ for 600 λ ; orange due to the sense organ for 580 λ ; and greenish-blue due to the connecting together of the sense organs for 540 λ, 520 λ and 500 λ with the green and blue visual centres (see Section 15).

Such vision would, I think, account for (*a*) the perception of orange as being different from red mixed with white, (*b*) the modification of crimson to orange, and lastly (*c*) the fact that the blue-green sensation has a strong predominance of blue.

15. *Hypotheses of the change from tri- to di-chromatic vision.*

Hypothesis 1. The change resembles simultaneous contrast in affecting the margins of the test object. Thus, suppose a yellow test object on a black ground to appear to the eye to have a narrow white margin, then as the test object is reduced in size the white margin should encroach more and more on the yellow central area until the whole of the test object has become white. This hypothesis was tested in two ways. (*a*) By taking two yellow test objects of the same area but very different shape, one square and one oblong. If this hypothesis were true, the square test object would require a much greater distance than the oblong one in order to become white. Experiments showed, however, that the two distances were nearly the same (see Section 2). (*b*) By taking two oblong test objects of the same shape and size, one having yellow edges and white centre, the other having white edges and a yellow centre, both on black backgrounds, the yellow areas being equal. If this hypothesis were true, the former ought to appear white at a shorter distance than the latter. Experiment showed the two distances to be nearly the same. This hypothesis must therefore be abandoned.

Hypothesis 2. That it is due to stray light entering the eye from surrounding objects. This hypothesis was tested by causing the observer to look down a narrow blackened tube at the yellow test object, the distance at which the transition of yellow to white occurred being noted. This distance was found to be the same as that obtained without the tube, so that stray light does not appear to be a contributory cause.

Other hypotheses similarly tested were : (3) that it is due to the chromatic aberration of the eye, (4) that it is due to haze between the test object and the observer. As none of these hypotheses explained the phenomenon, a physiological explanation must be looked for, such as the cancellation of a sensation as in protanopia (red blindness), or the linking of two sensations as in deutroanopia (green blindness)[8].

16. *Cancellation and linking.* Cancellation of the red sensation would cause white to appear blue-green ; cancellation of the green sensation would similarly cause white to appear purple ; while cancellation of the blue sensation would cause white to appear yellow[4]. Since white does not change in any of these ways, cancellation does not appear to account for the phenomena which are observed. Linking of red and green would cause one end of the spectrum to appear yellow and the other end blue. Linking of red and blue would cause both ends of the spectrum to appear purple, and the middle region to appear green. Linking of green and blue would cause one end of the spectrum to appear red and the other end blue-green. Of the three types of linking it is obvious that the last most closely fits the observed facts.

In one important respect, however, this plan requires modification, namely, with regard to the blue and violet parts of the spectrum. If there were simple linking and nothing more, then the blue and violet parts of the spectrum would be modified in colour to blue-green, but would retain their normal brightness when seen at small visual angles. Such, however, is not found to be the case, for there is always a considerable reduction of brightness in the case of both colours. When a very bright spectrum, such as that of a carbon arc, is examined in such a way that it subtends a very small angle at the eye, its short-wave end is found to terminate at the same wave-length as it does when it subtends a large angle at the eye. When, however, a spectrum of average brightness is examined in the same manner, then there is seen to be considerable shortening of the short-wave end when it subtends a small angle at the eye ; but little or no shortening when it subtends a large angle. This fits in with the observation that blue and violet test objects lit by ordinary daylight appear dark grey or black when they subtend small angles at the eye. If now their intensities be greatly increased, then both are seen to be blue-green in colour. A hypothesis which fits all the above facts is

that for test objects subtending small visual angles the brain centres for green and blue are linked together and are connected with the sense organs responding to green rays; while at the same time the sense organs responding to blue rays are temporarily put out of action.

17. *Nervous level of the mechanism.* A question which naturally presents itself concerns the position of this linking and cancelling mechanism. Is it situated in the retina, or in some part of the brain?

The following experiment points to a definite location. A grey test object is placed on a bright blue background in order to produce a yellow coloration of the former by simultaneous contrast. If now the distance between test object and observer be increased, it is found that the yellow coloration diminishes and at a certain distance disappears altogether, being replaced by white. This experiment shows that a subjective yellow behaves in the same way as a real yellow does with decrease in visual angle, and the mechanism producing the change must therefore operate on both. This mechanism must therefore be situated at a higher nervous level than the one which is responsible for simultaneous contrast. Now in Burch's celebrated experiment[6] in which, using a stereoscope, a grey test object on a blue ground was presented to one eye while another grey test object on a red ground was presented to the other, the two coloured grounds fused to form a single purple ground; but the grey test objects retained their individuality, that on the blue ground remaining yellow, that on the red ground remaining blue-green. This experiment showed that simultaneous contrast occurs at a nervous level below that at which binocular fusion occurs.

Now as we have said above, the mechanism for converting trichromatic to dichromatic vision appears to be situated at a higher nervous level than that responsible for simultaneous contrast. It might therefore be either between the levels for simultaneous contrast and binocular fusion or above both levels. Evidence has been obtained and will be described elsewhere that the former is probably the case.

I would like to express my thanks to those who have acted as observers for me.

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[3] Willmer, E. N., *Nature*, 153, 774 (1944).
[4] Hartridge, H., *Nature*, 155, 391 (1945).
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[6] Burch, G. J., *J. Physiol.*, 25, xvii (1900).
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OBITUARIES

Sir Ambrose Fleming, F.R.S.

JOHN AMBROSE FLEMING was born at Lancaster on November 29, 1849, and died at Sidmouth on April 18. He was the eldest son of the Rev. James Fleming. His mother was a daughter of John Bazley White, an engineer who pioneered the manufacture of Portland cement in Kent. About 1856 the Fleming family moved to London and in 1863 Fleming entered University College School. He has recorded that he was always at the bottom of the Latin classes though quick at mechanics and science. Evidently in these respects he was nearer his maternal grandfather than his father.

In 1866 Fleming entered University College, but he had to leave before graduating. For a year he worked in a shipwright's drawing office and then for two years as a stockbroker's clerk. In his leisure he prepared for the B.Sc. degree. In 1871 he became science master at Rossall School, and in two years saved enough to allow him to enter the Royal College of Chemistry, South Kensington. There, under Franklin, he began his research career, and in 1874 read his first paper, on a form of voltaic cell, at the first meeting of the Physical Society of London. His funds being spent, he went as science master to Cheltenham College and in two years saved enough to enter St. John's College, Cambridge, at the age of twenty-eight, with the aid of an open exhibition.

He attended Maxwell's lectures in 1878 and 1879, the last two years of Maxwell's life, and worked in the Cavendish Laboratory on electrical resistance standards. He obtained a first class in the Natural Sciences Tripos in 1880 and became lecturer in applied mechanics in the new University engineering laboratories. He was made a fellow of St. John's in 1882. After a short time at Nottingham, where he held the professorship of physics, he returned to London to start a consulting practice in 1882. In 1884 he was invited to become the first professor of electrical engineering at University College, and he occupied this chair for forty-one years, the inaugural period of the electrical age.

Fleming began his consulting career at the age of thirty-three by becoming adviser to the Edison Telephone Company and continued with it after it was combined with the Bell Telephone interests. Later, when the Edison Electric Light Co. was formed, he became its adviser on the equipping of generating stations and distribution networks. After the carbon filament lamp was invented, he became the adviser of the Edison and Swan combination, particularly on the photometry of lamps. Later he advised a number of English towns on the adoption of electric light. He was also consulted by the London Electric Supply Corporation when it was installing the Ferranti alternating current system in London. In 1899 he became consultant to Marconi's Wireless Telegraph Company and took part in the design of the Poldhu Station, the first large wireless station in England. In the course of this work he devised new methods and new instruments for the measurement of high-frequency current, and he was the first to demonstrate that the thermionic rectifier could operate at radio frequencies. Thus during many years and in many directions he assisted in the adaptation of revolutionary electrical industries to English conditions, and aided the technical development of many fundamental electrical inventions. As fast as he gathered experience in these new technical developments, he passed it on in lectures to his students and to public audiences. He also read widely the expanding electrical technology and lucidly expressed its essence in his lectures. Some of his lecture courses were published as text-books. Among such books, one recalls with gratitude "The Alternating Current Transformer", "The Principles of Electric Wave Telegraphy", "The Propagation of Electric Currents in Telephone and Telegraph Conductors", "Electric Lamps and Electric Lighting".

In the midst of all these applications of science to engineering, Fleming found time and energy for a number of physical investigations—for example, the measurement of the electrical and magnetic properties of materials at the temperature of liquid air. Alto-

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

(Public Notices)

UNIVERSITY OF EDINBURGH

Admissions—Session 1945–46

FACULTY OF MEDICINE

Entrance to the Faculty will be limited and candidates for admission in October, who have not already applied, must submit an application to the Dean of the Faculty of Medicine on a form to be obtained from him—not later than July 1, 1945.

FACULTIES OF ARTS (including COMMERCE and SOCIAL STUDY), SCIENCE, LAW and MUSIC.

The number of admissions to Courses in these Faculties will probably be limited.

Application should be made by July 15 on a form to be obtained from the MATRICULATION OFFICE, OLD COLLEGE.

Information regarding the conditions of admission to these Faculties may also be obtained at the MATRICULATION OFFICE.

All admissions will be subject to any regulations made by the Ministry of Labour and National Service.

A stamped addressed envelope (1d.) should accompany postal requests for forms.

W. A. FLEMING,
Secretary to the University.

ROYAL GEOGRAPHICAL SOCIETY

APPOINTMENT OF SECRETARY

The Council of the Royal Geographical Society invite applications for the post of Secretary of the Society. Candidates should submit their applications to the Hon. Secretaries of the Royal Geographical Society, Kensington Gore, London, S.W.7, before July 31.

The Secretary is the administrative head of the Royal Geographical Society and Editor of the *Geographical Journal*. Candidates must have scientific and academic background in Natural Science or Humanities relating to some aspect of geography with sufficient general qualifications to deal with all branches of geographical knowledge and research, and be between the ages of 35 and 50. Salary from £1,250 to £1,750 plus expenses. Preference will be given to candidates serving, or having served, in H.M. Armed Forces or on other National Service. Applications should include details of academic, scientific and literary experience, present occupation and release class, and references.

CITY OF LEICESTER EDUCATION COMMITTEE

LEICESTER COLLEGE OF TECHNOLOGY AND COMMERCE

Principal: L. W. Kershaw, O.B.E., B.Sc., A.M.Inst.C.E.

APPLICATIONS are invited for the post of Full-time LECTURER IN INORGANIC AND ANALYTICAL CHEMISTRY.

Applicants must be Honours Graduates and Research or Industrial Experience is desirable.

Salary will be in accordance with the New Burnham Scale, with allowances for approved Industrial, Research and Teaching experience.

Applications, together with copies of two recent testimonials and names of two persons to whom reference may be made, should be sent to the Principal, College of Technology and Commerce, The Newarke, Leicester, not later than June 9, 1945.

Further particulars of the appointment may be obtained from the Principal upon the receipt of a stamped addressed envelope.

H. S. MAGNAY,
Director of Education.

SHEFFIELD RADIUM CENTRE

Applications are invited for the post of ASSISTANT PHYSICIST

The successful candidate will be expected to work in the new Physics Department of the National Radium Centre at Sheffield and, also, to undertake duties in connection with affiliated Centres elsewhere. The initial salary will be in the Hospital Physicists Association's scale of £450–25–£600 (according to qualifications and experience), plus the cost of living bonus of £57 4s. per annum.

Applications should reach the undersigned not later than June 18.

THE SECRETARY.

Sheffield Radium Centre,
at The Royal Infirmary,
Sheffield, 6.

BLACKBURN EDUCATION COMMITTEE

MUNICIPAL TECHNICAL COLLEGE

SCIENCE DEPARTMENT

Applications are invited for the following posts as full-time lecturers.

1. Mathematics and Physics. Good Honours degree essential. Some experience in teaching to B.Sc. standard. Post of responsibility.

2. French and English (Man or Woman).

Salary in both cases in accordance with the new Burnham Provincial Scale for Technical Colleges. Duties to commence on September 1, 1945, or as soon as possible after that date.

Further particulars and forms of application may be obtained from the undersigned, on receipt of a stamped and addressed envelope, to whom completed applications should be returned not later than June 9, 1945.

G. F. HALL,
Director of Education.

Education Offices,
Library Street,
Blackburn.

SHEFFIELD RADIUM CENTRE

Applications are invited for the post of ASSISTANT TECHNICIAN. The successful candidate will work in the new Physics Department and workshops of the National Radium Centre at Sheffield. The initial salary will be £250 to £300 according to qualifications and experience, plus the cost of living bonus of £57 4s. and the benefits of the F.S.S.N.

Applications should reach the undersigned by June 25.

THE SECRETARY.

Sheffield Radium Centre, "Broom Cross",
Tree Root Walk, Sheffield, 10.

UNIVERSITY OF EDINBURGH

LECTURESHIP IN COLONIAL AND IMPERIAL HISTORY

Applications are invited for this Lectureship. The salary will be of the range of £550–£650 per annum, and the Lecturer will be required to join the Federated Superannuation Scheme. It is hoped that an appointment will be made as from October 1, 1945; but this will not preclude consideration of applications from persons serving in the forces or other branches of National Service who may not secure release by that date.

Further particulars may be obtained from the undersigned, to whom applications, with evidence of qualifications and the names of not less than three referees, should be sent not later than July 16, 1945.

W. A. FLEMING,
Secretary to the University.

UNIVERSITY OF BIRMINGHAM

MEDICAL OFFICER TO THE UNIVERSITY

The Council invites applications from Registered Medical Practitioners (Male) for the post of Medical Officer to the University.

The appointment will date from October 1, 1945, or January 1, 1946—salary £1,000 per annum.

Further particulars of the appointment and duties may be obtained from the undersigned, to whom applications (three copies) must be submitted, with the names of three referees, on or before September 3, 1945.

C. G. BURTON,
Secretary.

The University,
Edmund Street, Birmingham, 3.

UNIVERSITY COLLEGE, DUBLIN

Professorship of Chemistry, Professorship of Plant Pathology, Lectureship in Mechanical Engineering, Lectureship II in Experimental Physics, Lectureship in Statistical Mathematics, Lectureship in Ophthalmology.

Applications are invited by the Governing Body of University College, Dublin, for the above Statutory Offices. Applicants must forward to the Secretary and Bursar, University College, Dublin, copies of their applications and testimonials not later than June 1, 1945.

Further particulars may be obtained on application to:

A. J. O'CONNELL, M.Comm.,
Secretary and Bursar.

University College, Dublin.

WYE COLLEGE

(UNIVERSITY OF LONDON)

The Governors invite applications from men or women for the following appointments:

(1) Department of Agriculture—Head of Department, salary £1,000–£1,200. (2) Department of Horticulture—Head of Department, salary £1,000–£1,200. (3) Department of Chemistry—Head of Department, salary £800–£900. (4) Lecturer in Fruit Growing, salary £425–£625. (5) Lecturer in Chemistry (also qualified to give instruction in Elementary Physics), salary £425–£625. (6) Assistant Lecturer in Chemistry, salary £375. (7) Lecturer in Surveying and Building Construction, salary £425–£625.

Closing date for receipt of applications, June 9, 1945.

Further particulars regarding any of the above appointments may be obtained from the Acting Principal, Wye College, Wye, nr. Ashford, Kent.

WYE COLLEGE

(UNIVERSITY OF LONDON)

The Governors invite applications from women for the post of VICE PRINCIPAL (resident). Applicants should have had University teaching experience in Science, Horticulture, Agriculture or Economics. Salary £750–£950 with superannuation under the F.S.S.U. Further particulars may be obtained on application to the Acting Principal, Wye College, Wye, nr. Ashford, Kent. Closing date for receipt of applications, June 9, 1945.

WYE COLLEGE

(UNIVERSITY OF LONDON)

The Governors invite applications from men for the post of SECRETARY & REGISTRAR. Applicants must be University graduates with experience in office administration. Salary (non-resident) £600, rising by annual increments of £20 to £700 with superannuation under the F.S.S.U. Further particulars may be obtained from the Acting Principal, Wye College, Wye, near Ashford, Kent. Closing date for receipt of applications, June 9, 1945.

LOUGHBOROUGH COLLEGE

Principal: Dr. Herbert Schofield, M.B.E.

DEPARTMENT OF PURE AND APPLIED SCIENCE

Applications are invited for the position of Lecturer in Physics up to Degree standard. Honours Graduate with research and industrial experience preferred. Salary will be in accordance with the Burnham (1945) Scale for Technical Colleges, with a special responsibility allowance for a suitably qualified and experienced candidate. Further details and form of application, which should be returned by June 7, may be obtained from the Registrar, Loughborough College, Loughborough, Leics.

UNIVERSITY OF DURHAM

Applications are invited for the Readership in Entomology, tenable at King's College, Newcastle-upon-Tyne. The candidate appointed, if now on National Service, will not be expected to take up appointment until his release. The salary offered is £750 per annum.

Further particulars may be obtained from the undersigned, by whom applications should be received not later than June 30, 1945, although consideration will be given to later applications from those serving overseas.

G. R. HANSON,
Registrar of King's College.

KING'S COLLEGE NEWCASTLE-UPON-TYNE

IN THE UNIVERSITY OF DURHAM

Applications are invited for the post of Lecturer in Applied Mathematics. Duties to commence October 1, 1945. Initial salary will be between £450 and £550 according to qualifications and experience. Further particulars may be obtained from the undersigned to whom four copies of application, together with the names of not more than three referees, should be sent not later than Saturday, June 9, 1945.

G. R. HANSON,
Registrar of King's College.

UNIVERSITY OF OXFORD

LINACRE PROFESSORSHIP OF ZOOLOGY AND COMPARATIVE ANATOMY

Applications are invited for the above Professorship and should reach the Registrar of the University not later than July 7, 1945. Stipend £1,400 per annum (plus children's allowances and subject to general reconsideration of stipends). Residence required during six months in each academic year. Retiring age 65. Further particulars may be obtained from the Registrar, University Registry, Oxford.

BATTERSEA POLYTECHNIC

LONDON, S.W.11

The Governing Body invites applications for the full-time post of LECTURER IN MATHEMATICS, to commence duties in September. Candidates must have a good honours degree in Mathematics, preferably with special interests in Applied Mathematics. Further particulars may be obtained from the Clerk to the Governing Body, to whom applications should be sent not later than June 11, 1945.

UNIVERSITY COLLEGE LEICESTER

The Council invites applications for the post of LECTURER IN CHARGE of the Department of Zoology as from October 1, 1945. Salary not less than £500 p.a.

Applications should be submitted not later than June 20, 1945, to the Registrar from whom further particulars may be obtained.

IMPERIAL COLLEGE OF SCIENCE AND TECHNOLOGY

DEPARTMENT OF MATHEMATICS AND MECHANICS

With effect from October 1, 1945, several junior appointments in this Department will be made in the grades of Assistant Lecturer (Scale £350 : £375 : £400) and Demonstrator (£250 : £275 : £300), with F.S.S.U. membership; tenure limited to three or four years.

Applications to The Secretary, Imperial College, London, S.W.7.

BEDFORD COLLEGE FOR WOMEN

(UNIVERSITY OF LONDON)

Regent's Park, N.W.1

LABORATORY APPRENTICES WANTED IMMEDIATELY in the Departments of Botany, Physics and Physiology at Bedford College. Salary £1 10s.–£2 10s. per week. Initial salary according to age, qualifications and experience. Applications to The Secretary.

CARDIFF ROYAL INFIRMARY

Applications are invited for the post of Senior Physicist to the Department of Radiotherapy. The Department is a major centre for South Wales and Monmouthshire. Salary in accordance with the scale of Hospital Physicists' Association. Written applications to the Medical Superintendent, Cardiff Royal Infirmary.

Pharmacologist. Applications are invited for a permanent and pensionable position of pharmacologist to a well-known company with the progressive policy towards development and research. For the first year or longer the work will be carried out in a university laboratory and opportunities for research offered. An early opportunity of designing a new and well equipped laboratory will be given. Applicants must hold an Honours degree in Physiology or a medical qualification, and have had previous pharmacological experience. Commencing salary £600–£1,000 per annum according to previous experience. Box 367, T. G. Scott & Son, Ltd., 9 Arundel Street, London, W.C.2.

Alloy Manufacturers in Southern England require qualified Metallurgist, age 20–35, of degree standard. Knowledge of Ferrous Metals desirable. Permanent employment with good prospects. Salary £450/£600 per annum. Write, quoting F.3895.XA, to Ministry of Labour and National Service, Central (T. & S.) Register, Room 5/17, Sardinia Street, Kingsway, London, W.C.2, for application form which must be returned completed by June 26, 1945.

Graduate Physicist, aged 21 to 36, required to take control of Section of Physics Laboratory. Chance Brothers, Limited, Glass Works, Smethwick

University of London. The Senate invite applications for the Chair of Physiology tenable at King's College of Household and Social Science (salary not less than £1,100). Applications must be received, not later than first post on June 26, 1945, by the Academic Registrar, University of London, Richmond College, Richmond, Surrey, from whom further particulars should be obtained.

A firm of Fine Chemical Manufacturers of national repute in the London area requires a number of Young Chemists for Plant and Development work in the field of Organic Chemistry and Biochemistry. Commencing salaries will depend on qualifications and experience. Applications from recent graduates are invited. Good prospects. Box 368, T. G. Scott & Son, Ltd., 9 Arundel Street, London, W.C.2.

Assistant Chemist (Graduate) required for Chemical Laboratory in London of radio component manufacturers. Previous experience of works problems desirable. Salary £500–£550 per annum according to experience. Write quoting F.3237.XA to Ministry of Labour and National Service, Central (T. & S.) Register, Room 5/17, Sardinia Street, Kingsway, London, W.C.2, for application form which must be returned completed by June 19, 1945.

Man wanted immediately for scientific observations of seaweed survey work in Scotland on board a vessel. An algologist preferred but not essential. Robust health necessary. Salary according to experience and qualifications approximately £400. Subsistence rates according to scale. Particulars to Scottish Seaweed Research Association, King's Buildings, West Mains Road, Edinburgh, 9.

Wanted: Fieldman to assist Advisory Chemist. Degree desirable. Approximate salary and bonus £300. Applications with two testimonials should reach Registrar, Leeds University, by June 9.

Microscopes, of all descriptions, only a few available, second-hand, perfect condition. Send details of your requirements, enclosing 8d. stamp.—Telephone or correspondence only, Chards, Forest Hill, S.E.23 (Spring Park 1628).

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gether he wrote more than a hundred research and descriptive papers. He was elected to the fellowship of the Royal Society in 1892 and received the Hughes Medal of the Society in 1910; he was also awarded the Albert, the Faraday and the Duddell Medals; and in 1929 he was knighted.

As a teacher Fleming was superb. He had the gift of arranging his subject-matter attractively and of stating his facts and ideas emphatically. He talked straight on, without digressions, doublings, or repetitions, in a direct current of well-chosen words and rounded sentences. His delivery was very rapid; but his resonant voice and crisp articulation ensured that no one missed a word. Nor did anyone ever complain that his meaning was doubtful; everything was sharply defined. After middle age he became very deaf, but retained all his magic as a lecturer. This deafness, by the way, was utilized by his students when in jubilant mood; on such occasions a stranger passing the door of the lecture room might hear a sudden clamour and its sudden cessation, and if he lingered he would hear the uproar switched on and off at intervals. Inside the lecture room he would have seen that when the professor turned to the blackboard there was pandemonium, and when he faced his class there was silence. The timing had to be lively as Fleming was quick in his movements. This celerity was characteristic; even when he was in the middle seventies, one could see his linear figure threading swiftly a populous corridor in the College, intent on a goal, looking neither right nor left, overtaking everybody. Indeed in intellectual as well as material things, Fleming's main principle of action was, full-speed ahead. W. H. ECCLES.

Dr. David Randall-MacIver, F.B.A.

DR. D. RANDALL-MACIVER, the accomplished archæologist and anthropologist, was born in 1873, and educated at Radley and the Queen's College, Oxford, where in 1896 he obtained a first class in *Literæ Humaniores*. It had been his youthful ambition to devote himself to the pre-Columbian cultures of America, but as this seemed impracticable, he came easily under the influence of Sayce and Grenfell at Queen's, and learned the technique of Egyptian excavation with Flinders-Petrie. He was the first holder of the Laycock Studentship for Egyptology at Worcester College (1900–6) and in 1907 directed the Eckley B. Coxe, jun., Expedition of the University of Philadelphia to Egypt and the Sudan; publishing also with Arthur Thomson a detailed anthropometric study of ancient Egyptian skeletons.

When the British Association visited South Africa in 1904, Randall-MacIver was entrusted with a reconnaissance of the 'Zimbabwe' type of ruins in Rhodesia, and his rapid but careful and conclusive excavations on a few typical sites demonstrated their late date, and caused some indignation locally when they were published in his "Mediaeval Rhodesia". After some work in the Pennsylvania Museum, he became librarian of the American Geographical Society (1911–14), married an accomplished Virginian lady, and seemed to be settling down in New England.

But the War of 1914–18 recalled him to Europe as an efficient intelligence officer in France and in Macedonia—he spoke French, German and Italian with equal facility—and after 1919 he settled in Florence and devoted himself to the prehistoric antiquities of Italy, to which his attention had been attracted by another Queen's man, the late T. E. Peet, whom MacIver had sponsored in his early years, and with whom, in a manner, he changed careers, when Peet left Italian prehistory for Egyptology. Peet's "Stone and Bronze Ages in Italy and Sicily" (1909) was a pioneer survey of the earlier periods; Randall-MacIver took up the story in 1924 with a stately volume, "Villanovans and Early Etruscans", tracing through tangled and sometimes passionate Italian publications the main theme of the continuity of native Italian culture, and its gradual transformation by the Early Etruscan, which intruded on its region from the south. In 1927 came a companion study of "The Iron Age in Italy", dealing with the cultures of central and southern Italy, neither Villanovan nor Etruscan, which betray early and increasing signs of intercourse with regions east of the Adriatic.

In this way a new approach was prepared to the residual problem of the Greek colonization, and of the foreign imports which portend the first reconnaissance of 'Magna Graecia'. To this, Randall-MacIver had intended to devote a third memoir; but his many social and personal interests and the death of his wife in 1931 intervened; all that he left on this subject was a charming book of travel, "Greek Cities in Italy and Sicily" (1931). In 1936, he married another American lady, and on the outbreak of war in 1939 withdrew from Italy to New York, where he was able to do valuable services in the British war organization. There he died on April 30, 1945. JOHN L. MYRES.

Prof. Thomas J. Nolan

THE news of the death of Prof. Thomas J. Nolan on March 12, at the age of fifty-six, came as a profound shock to his colleagues and students.

Graduating in University College, Dublin, in 1909 with the highest honours in chemistry, Nolan commenced research work under the late Prof. Hugh Ryan and was awarded a travelling studentship in chemistry in 1911, his thesis dealing with a research on "The Higher Ketones and Secondary Alcohols derived from the Amides of Palmitic and Stearic Acids". In the autumn of 1911, Nolan proceeded to Geneva and commenced research under Amé Pictet on problems dealing with the "Constitution of Isostrychnine" and the "Application of Methylal in Ring Syntheses". Owing to the illness of Pictet this work was not completed. In 1912 he began research under Prof. Samuel Smiles in University College, London, on the "Isomerism of the Sulphides of β-Naphthol", the results being embodied in a series of five papers in the *Proceedings and Transactions of the Chemical Society*, London. In 1913, Nolan worked under Zincke in the University of Marburg and published in *Liebigs Annalen* a communication entitled "Saltpetersaürechinitrol aus 3. 5. 6 Trichloro-o-Kresol und Umwandlungsprodukte". His most distinguished work at this period was carried out in the Kaiser Wilhelm Institut in Berlin, where Willstätter was engaged on his classic investigations on the colouring matters of flowers and fruit. Under Willstätter's direction Nolan succeeded in isolating the pigments of the rose and peony in a pure condition and establishing their constitution. The outbreak of war in 1914 terminated these researches, and he returned to Dublin and was awarded the D.Sc. degree of the National University.

During 1915–25, Nolan was engaged as research chemist to Messrs. Nobel's Explosives Co., Ltd., during which period he carried out many valuable researches. In 1925 he returned to Dublin to become assistant State chemist and afterwards State chemist, a post which he held until his appointment in 1932 as professor of chemistry in University College, Dublin.

Much of the research which Nolan carried out during the past thirteen years was directed towards the investigation of the chemical constituents of lichens found in Ireland. In this very difficult field he was the first to isolate a chlorinated depsidone, gangaleoidin, and had gone far towards establishing the constitution of this and other organic substances containing chlorine, which are found in lichens. More recently, he had isolated two nitrogenous constituents in the lichen *Lecanora epanora*.

Among his many activities Nolan served on the council of the Chemical Society, London, during 1926–29. He was chairman of the Board of the Industrial Alcohol Factories established by the Irish Government, member of the Irish Industrial Research Council and during the emergency created by the War his advice was frequently sought and highly valued both by the State and industrialists.

Nolan was an inspiring teacher, a loyal and understanding colleague, a staunch friend and a chemist of the highest calibre. His death at the height of his powers is a grievous loss to chemistry and to his University.

JOSEPH ALGAR.

WE regret to announce the following deaths :

Prof. A. Fersman, the distinguished Russian geologist and mineralogist, aged sixty-one.

Sir Martin Forster, F.R.S., during 1922–23 director of the Indian Institute of Science, Bangalore, on May 24, aged seventy-two.

Mr. G. C. Robson, formerly of the British Museum (Natural History), where he was in charge of the collection of Mollusca, on May 17.

NEWS and VIEWS

Geology at the University of Sheffield : Prof. W. G. Fearnsides, F.R.S.

NOT a few of the younger generation of geologists will learn with surprise of the retirement of Prof. W. G. Fearnsides from the Sorby chair of geology at the University of Sheffield. They will have ample ground for wonder whether anyone so patently young can have reached the age at which university professors retire, though the surprise may be lessened by the discovery that he has held the chair since its foundation thirty-two years ago, and consolation will follow the thought that geology still has the promise of his enthusiasm and energy for many years to come. Under McKenney Hughes, as a colleague of Alfred Harker, J. E. Marr, Henry Woods and Gertrude Elles, he commenced his geological career in some of the brightest days of the Cambridge school. It is not surprising that some of his earliest claims to distinction were notable contributions in the Cambridge tradition of Lower Palæozoic geology, while his characteristic versatility was foreshadowed by his concern at the same time with the teaching of petrology and the collection of quaternary bones. During this period he was a fellow of Sidney Sussex College.

Shortly after his acceptance of the Sorby chair, Prof. Fearnsides remarked on one occasion that the time had come to apply the lessons learned in the minute study of the lower Palæozoic to the problems of the Coal Measures. His publication shortly thereafter of a structural map of the Yorkshire Coalfield laid the foundation of much work by himself and others, which has given greatly increased precision to knowledge of Carboniferous and post-Carboniferous earth-movements and their consequences. Among industrialists and engineers, Fearnsides has performed a notable service in demonstrating the value of geology in those spheres, whether concerned with fuels, metals, refractories, bricks or roads. For him there is no 'pure' or 'applied' science. He is equally at home in the councils of the Institutions of Mining Engineers, or of Mining and Metallurgy, or in the presidential chair of the Geological Society or of Section C (Geology) in the British Association. In the Royal Society his work for geology has been outstanding, and all will wish that in this and other spheres it may long continue.

Major F. W. Shotton, R.E.

PROF. FEARNSIDES is being succeeded by Major F. W. Shotton, R.E. After a brilliant undergraduate career at Cambridge, Mr. Shotton was appointed to a lectureship at the University of Birmingham, where he worked under Prof. W. S. Boulton and Prof. L. J. Wills. During this time he carried out important work on the rocks of the Coventry district ; he also studied the conditions of deposition of the Trias Sandstones with the aid of students from the University of Birmingham, whom he organized into teams for field-work. In 1936 he returned to Cambridge as lecturer under Prof. O. T. Jones and carried out detailed research in the Cross Fell district of the Pennine Chain.

In 1940 Shotton was asked to take an appointment as geologist with the Armies in France ; but the need for the appointment disappeared with the return of the B.E.F. to Great Britain. Shotton was eventually commissioned in the Royal Engineers in the autumn of 1940 and proceeded to the Middle East as geologist on H.Q. staff. Here he carried out excellent work mainly concerned with water-supply problems. In 1943 he was appointed as geologist to the Chief Engineer, Twenty-first Army Group, in succession to Prof. W. B. R. King. During the time before *D*-day, Shotton was busy studying many problems connected with the Normandy landings, particularly in connexion with the behaviour of various types of beach under different loads, and reaction to shelling, condition of river banks and bottoms, water supply and suitability of sites for the construction of landing strips for fighter aircraft. Shortly after *D*-day, he was in Normandy putting the results of this study into practice, and has been with the armies throughout their advance into Germany. During this time he

has justified to the full the appointment of a geologist to the staff of the Chief Engineer. His election to the chair of geology at Sheffield, while enabling him to return to the pursuit and teaching of pure science as a basic study, will enable him to continue to maintain and emphasize the value of geology to all civil engineering practice, as he has done to military engineering in its widest sense.

Chair of Geology at Leeds: Prof. W. Q. Kennedy

DR. W. Q. KENNEDY, who has been appointed to the chair of geology in the University of Leeds, is a senior geologist on the staff of the Geological Survey in Scotland. Before joining the Geological Survey in 1928, Kennedy studied under J. W. Gregory in Glasgow and under Niggli in Zurich. As a result of his Continental training, he became one of the first geologists in Britain to apply Fedorow and Sander 'universal stage' technique to the microscopic study of rocks, and early in his career published a translation of Chudoba's text-book on the determination of plagioclase feldspars by 'universal stage' methods. Kennedy has made notable contributions to geological research. In petrology he has dealt with pyrometasomatic ore-deposits, composite lava-flows, the parent magma of the British Tertiary Province and, in conjunction with Dr. E. M. Anderson, the origins of basaltic magma. His conception of volcanic and plutonic associations has been acclaimed as a fundamental contribution to petrogenetic theory. Perhaps his most notable work in Scotland is his study of the Great Glen Fault, which led him to infer a lateral shift of some 65 miles along this fracture and to discuss its tectonic and metamorphic implications. His official Survey work with Dr. J. E. Richey on the Moine and sub-Moine rocks of the Morar district has also produced notable results in Highland stratigraphy and tectonics.

Prior to the opening of the new Geological Museum in London in 1935, Kennedy spent a year or two in London preparing the ground-floor exhibits illustrating volcanicity and glaciology. During the War, he has been concerned with economic investigations on Scottish feldspar mica, iron-ore, oil-shale, mineral oil, natural gas and dolomite. His pre-war discovery of a valuable muscovite deposit in the Scottish Highlands has proved to be of national importance.

University Development at Birmingham

THE University of Birmingham has launched an appeal for £1,500,000 for purposes of development, and promises of £638,636 have already been received. Outstanding items in the proposed scheme are £100,000 each for four additional halls of residence (three for men and one for women), £200,000 for a new library, £170,000 for new laboratories for mechanical and electrical engineering, £150,000 for buildings at Edgbaston to house the Faculties of Arts, Commerce and Law, and central administration, and £40,000 each for the endowment of chairs of geography and electronics. In the words of the Vice-Chancellor, Dr. Raymond Priestley, "Men and women who must guide and control a great industrial people, and the experts who are to be the spear-point of scientific industry, are best educated within sight and sound of the factory and the market-place. We are moving forward into a world in which technical development will take place at an accelerating rate. To equip ourselves for the competition we shall have to face in order to maintain our standard of living—if not our very existence—in the post-war world involves mobilization of the skill and talent of the whole people, together with development of character, to put the programme through. We need to combine the best features of the older universities with the specialities of the new that are in closer touch with the industrial world. Given the will and the apparatus, there is nowhere that this could be done better than here in Birmingham."

Industrial Ophthalmology

THE Institute of Ophthalmology, Royal Eye Hospital, St. George's Circus, London, S.E.1, proposes to devote a considerable proportion of its funds to industrial ophthalmology. In view of the absence of any co-ordinated work in this field, it is felt that a national survey of workers, and of work already accomplished, is a necessary preliminary to the undertaking of research on any specific aspect of this very extensive subject. The Institute therefore invites those who have routine experience in any branch of industrial ophthalmology, or who have undertaken original work bearing upon it, to communicate with the Institute stating briefly their experience and defining the aspect of the work with which they are most familiar—medical supervision, safety, lighting, industrial psychology, etc. It is the Institute's policy to promote the investigation of industrial ophthalmic problems in the districts in which they arise. It is hoped that those replying to this request will be willing to co-operate in their own areas and in their special fields of interest and experience as the national scheme develops. This invitation is extended not only to individual workers, but also to research and other organizations concerned. The funds will be distributed on the recommendation of the Scientific Executive Committee in the form of grants for approved work. The Committee proposes, initially, to support, co-ordinate and publish work undertaken throughout Great Britain.

Industrial Data in Britain

ACCORDING to an article in the *Board of Trade Journal* of May 26, 1945, the Board of Trade is to undertake, through the regional research sub-committees formed as adjuncts to the Distribution of Industry Committees, the collection and assembly, on a continuing basis, of a wide range of factual data required for distribution of industry purposes covering every locality in Britain. In making such surveys the Board of Trade will make the fullest use of information on industry already accumulated by the supply Ministries and by the Ministries of Labour and Town and Country Planning. It is also intended to take the fullest advantage of local knowledge by consultation with non-official bodies, whether universities, local authorities or industrial groups. By these means the Board of Trade should be made conversant with the industrial problems of all parts of the country and equipped to provide the industrial world with an information service to help individual firms in making decisions on the location of new factories.

Astronomical Observatory of Madrid

THE *Anuario* for 1945 of the Madrid Observatory has been prepared on a plan similar to that of the preceding issues, with some slight modifications intro-

duced in the year-book for 1944. Observations and records of solar activity during 1944 have continued, and the results, together with those made at the observatories of Valencia and Cartuja, have been sent to the International Bureau at Zurich. Time signals have been carried out, and photographs of comets and planets, occultations of stars by the moon and other notable phenomena have been included in the programme. *Boletin Astronómico*, 2, No. 10, contains the results of observations of sunspots and prominences in 1938 and the positions of a number of comets observed in 1941 and 1942, while *Bol. Ast.*, 3, No. 1 contains the results of solar observations made in 1939 and 1940, including also those made during the latter year at Valencia. Repairs were started in the Observatory, those to the astrographic pavilion being completed, and the installation of the instrument and the new cupola to house it will allow the renewal of observations. At the end of the year-book there is an interesting section containing 72 pages with the title "El Sistema Galáctico", by José María Torroja Menéndez. This provides a very useful summary of our knowledge of the galaxy.

Belgian Scientific Delegates in Britain

A THIRD group of Belgian professors representing the Belgian Fondation Universitaire is now visiting Britain for a fortnight at the invitation of the British Council. They are visiting universities or research institutions in London, Reading, Oxford, Cambridge, Newcastle, Aberdeen, Edinburgh, Liverpool and Greenwich, and the I.C.I. works at Billingham. The delegates are: Prof. F. Van den Dungen, professor of analytical mechanics, University of Brussels; Prof. A. Michotte van den Berck, professor of experimentary psychology, University of Louvain; Prof. A. Gratia, professor of bacteriology, University of Liège; Prof. J. A. H. Rodhain, director of the Institute of Tropical Medicine, Antwerp; Prof. E. J. M. P. Mertens, professor of industrial chemistry, University of Louvain.

Cambridge Summer School in X-Ray Crystallography

A SUMMER school in X-ray crystallography will be held again this year in the Department of Mineralogy and Petrology, and in the Cavendish Laboratory, Cambridge, during the two weeks September 3–14. The school is conceived as a means of providing an introduction to the fundamental theory, methods and techniques of X-ray diffraction, so that those whose researches, whether in the universities or in industry, lie in the field of physics, chemistry, metallurgy, mineralogy or biology may be able to recognize in their own work the types of problem to which these methods may with advantage be applied. The greater part of the course will be devoted to practical work on the interpretation of the various types of X-ray photograph. For the last two days, however, alternative lectures and demonstrations will be offered in two sections. One section will include further steps, theoretical and practical, in the study of crystal structures, while in the other some applications of the earlier work of the course to metallurgical problems will be studied. A detailed syllabus and form of application for admission may be obtained from Mr. G. F. Hickson, secretary of the Board of Extra-Mural Studies, Stuart House, Cambridge, to whom the completed application form should be returned not later than June 23, 1945.

Announcements

THE following appointments in the Colonial Services have been made: W. J. Kinghorn, to be director of agriculture, Bermuda; Miss B. Y. Campbell, to be nutrition officer, Trinidad; T. A. Russell, director of agriculture, Bermuda, to be agricultural officer, Nigeria; N. M. Wight, agricultural officer, Tanganyika, to be senior agricultural officer, Jamaica.

AT the anniversary meeting of the Linnean Society of London held on May 24, the following were elected officers for the year 1945–46: *President*, Mr. A. D. Cotton; *Treasurer*, Colonel F. C. Stern; *Secretaries*, Dr. B. Barnes (botany) and Dr. Malcolm A. Smith (zoology); *New Members of Council*, Mr. A. H. G. Alston, Prof. T. A. Bennet-Clark, Dr. F. C. Fraser, Dr. H. S. Holden and Dr. S. M. Manton.

AT the annual general meeting of the Physical Society on May 23 the following were elected or re-elected for 1945–46: *President*, Prof. D. Brunt; *Vice-Presidents*, Sir Edward Appleton, Prof. S. Chapman, Prof. H. T. Flint, Prof. N. F. Mott; *Hon. Secretaries*, Mr. J. H. Awbery (*Papers*), Dr. W. Jevons (*Business*); *Hon. Foreign Secretary*, Prof. E. N. da C. Andrade; *Hon. Treasurer*, Dr. C. C. Paterson; *Hon. Librarian*, Prof. L. C. Martin; *Council*, Prof. J. D. Bernal, Dr. B. Chalmers, Dr. C. H. Collie, Mr. E. R. Davies, Prof. G. I. Finch, Dr. W. B. Mann, Mr. A. J. Philpot, Dr. D. Roaf, Prof. H. R. Robinson, Dr. H. Shaw, Dr. W. S. Stiles, Dr. W. D. Wright. The officers of the Colour Group for 1945–46 are: *Chairman*, Dr. R. K. Schofield; *Secretary*, Dr. W. D. Wright; and of the Optical Group, *Chairman*, Inst. Capt. T. Y. Baker; *Secretary*, Mr. E. W. H. Selwyn.

AT the annual general meeting of the Illuminating Engineering Society held on May 15 the following were elected officers for the forthcoming session: *President*, Mr. H. C. Weston; *Vice-Presidents*, Mr. Howard Long, Mr. H. E. Chasteney and Mr. J. M. Waldram; *Hon. Treasurer*, Mr. N. V. Everton; *Hon. Secretary*, Mr. J. S. Dow; *Members of Council*, Mr. J. N. Aldington, Mr. M. G. Bennett, Dr. W. M. Hampton, Mr. A. G. Higgins, Mr. J. S. Preston, Mr. A. J. Pashler, Mr. E. B. Sawyer, Dr. W. S. Stiles and Dr. W. D. Wright.

AT the meeting of the Board of the Finney-Howell Research Foundation, Inc., on March 2, fellowships were renewed for the third year for Dr. Nelicia Maier; for the second year for Drs. Muriel Virginia Bradley and Margaret Aston Kelsall; and a new fellowship awarded to Dr. Elizabeth Cavert Miller, to work at the University of Wisconsin. Applications for fellowships for 1946 must be made to the Foundation, Medical and Chirurgical Faculty Building, 1211 Cathedral Street, Baltimore, Md., U.S.A., before December 1945.

THE Leeds Branch of the Association of Scientific Workers will hold an open conference on "Science and Education" at the Philosophical Hall, City Museum, Leeds, on June 9, at 2.30 p.m. It is hoped to discuss the teaching of scientific method in elementary education, the comparative value of science and the humanities in general education, and curricula for specialist technicians. Sir Robert Watson-Watt will open the discussion and Dr. W. T. Astbury will preside. Tickets of admission (price 1*s.*) can be obtained from the honorary secretary of the Leeds Branch of the Association of Scientific Workers, 95 Holywell Lane, Glasshoughton, Castleford.

LETTERS TO THE EDITORS

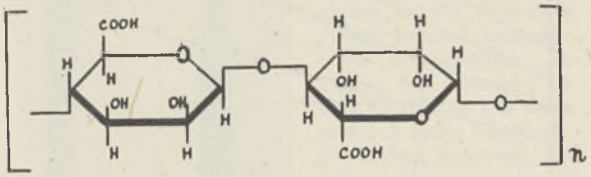
The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications.

Structure of Alginic Acid

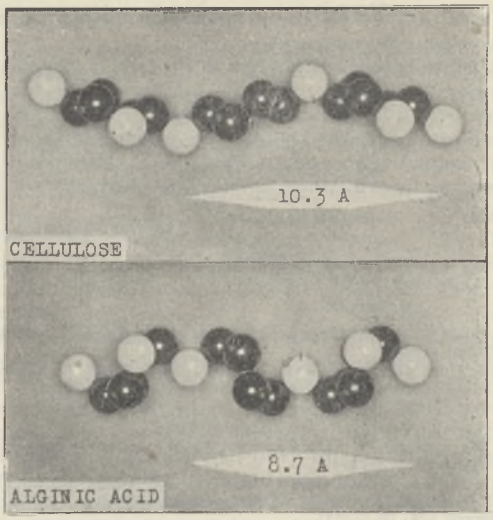
THE following is a short account of work completed a matter of two years ago; but publication at the time was forbidden. It was carried out in connexion with the production of rayon from seaweed described by Speakman and Chamberlain[1], and for the preparation of the fibres I am indebted to Dr. Chamberlain.

The alginic acid fibres finally arrived at gave at ordinary humidity a well-oriented X-ray diagram that could be evaluated without ambiguity. At this humidity the unit cell contains four mannuronic acid residues and perhaps four water molecules—it is difficult to be more definite than this, because both inter- and intra-crystalline water is present, and the density of the crystallites is not necessarily the same as that of the fibres as a whole; if we assume that it is, then the intra-crystalline water approaches four molecules per cell. Through the cell two chain-molecules run in opposite directions, one through the corners and the other through the middle of the (010) face, as in cellulose. On drying the fibres intensively the a-axis decreases and the X-ray pattern deteriorates; but the change is completely reversible on re-exposure to the atmosphere. From dryness to wetness the cell dimensions are: $a = 7{\cdot}7_5$–$8{\cdot}7$ A., b (fibre axis) $= 8{\cdot}7$ A., $c = 10{\cdot}6$ A. The space-group is probably Q^3 ($P2_12_12_1$), but it approximates to Q^4 ($P2_12_12_1$). The dry density was found by Dr. Chamberlain to be 1·627 gm./c.c.

The evidence from X-ray analysis is all in favour of the pyranose formula for alginic acid[2] [see also p. 655]:



and interest centres therefore in why the period along the fibre axis should be 8·7 A. instead of the 10·3 A. found in cellulose. There is no reason from the properties of the fibres to think that the chain of β-d-mannuronic acid residues is not stereochemically fully extended, so presumably the cellulose and alginic acid configurations are alternatives derivable from common postulates. As already indicated in a previous communication on the structure of cellulose[3], we find this to be so: there is no need to depart significantly from the usual interatomic distances and interbond angles, and the Sachse strainless ring in the so-called 'armchair' form constructed to these dimensions suffices for both cellulose and alginic acid. The difference lies simply in this, that there are two possible directions of the bonds joining C_1 and C_4 to the glucosidic oxygens, and the flatter arrangement is found in cellulose and the other in alginic acid. The idea will be clear from the skeleton models illustrated. Taking the carbon bond angle to be tetrahedral, the oxygen bond angle to be 110°, C—C = 1·54 A., and C—O = 1·42 A.[4], the calculated fibre period for cellulose comes to $10{\cdot}3_6$ A. and that for alginic acid to $8{\cdot}7_0$ A., as compared with 10·3 A. and 8·7 A. given by X-rays.



SKELETON MODELS OF THE CHAIN CONFIGURATION IN CELLULOSE AND ALGINIC ACID.

It is important to realize that the two configurations are not independent: one is not the prerogative of cellulose and the other of alginic acid, for in principle either may pass over into the other by intramolecular oscillation, as is easily seen on manipulating a model made with flexible bonds. The cellulose we know has one form and the alginic acid we know has the other, but it is conceivable that conditions, or derivatives, may be found for either that favour a change-over. For example, it has rather come to be expected that cellulose derivatives will be found always to have a fibre period that is a multiple of 5·15 A., and on this basis the 25·6 A. period of trinitro-cellulose has been assumed to correspond to the length of five residues; but it is not impossible that it corresponds actually to six residues in the alginic acid configuration. Similar remarks may apply to the 38·3 A. period given by d-camphor nitrocellulose-I[5], which on current ideas would appear to correspond to $7\frac{1}{2}$ residues.

Another point worth emphasizing is that the two kinds of chain just described are not specially a consequence of the β-linkage. Our present fibre photographs of pectin are not as well resolved as those of alginic acid, but there can be little doubt that they are of the alginic acid type. But pectin is based chiefly on chains of α-galacturonic acid residues: the respective dispositions of hydroxyl groups in cellulose, alginic acid, and pectin are such that to produce the same result requires the β-linkage in the first two but the α-linkage in the last.

These findings, taken in conjunction with those of Cox and his collaborators[6], go far towards establishing that the structural scheme for sugars formulated by Haworth and his school finds three-dimensional expression in the various configurations that are derivable simply by use of atomic distances and angles found to hold in less complicated aliphatic molecules, as, indeed, the sugar chemists themselves have long supposed. It is of great interest now to try to identify other theoretically possible examples besides the two discussed here, and also to determine what it is, in terms of physico-chemical conditions and the nature and arrangement of side groups, that decides the arrangement found in cellulose on one hand and that in alginic acid and pectin on the other. With

this end in view the investigation is being resumed with other polysaccharides.

I wish to record my thanks to Prof. J. B. Speakman and Dr. N. H. Chamberlain for supplying all the alginic acid fibres examined, to Drs. F. O. Bell, K. M. Rudall and M. M. Davies for much help on the experimental side, and to Prof. E. L. Hirst and his colleagues for guidance among the chemistry of the sugars.

W. T. ASTBURY.

Textile Physics Laboratory,
University of Leeds.
March 19.

[1] Speakman, J. B., and Chamberlain, N. H., *J. Soc. Dyers and Colour.*, 60, 264 (1944).
[2] Lunde, Heen and Öy, *Koll.-Z.*, 83, 196 (1938). Hirst, E. L., Jones, J. K. N., and Jones, W. O., *J. Chem. Soc.*, 1880 (1939).
[3] Astbury, W. T., and Davies, M. M., *Nature*, 154, 84 (1944).
[4] See Pauling's "Nature of the Chemical Bond".
[5] See, for example, K. H. Meyer's "Natural and Synthetic High Polymers", p. 280.
[6] Cox, E. G., and Jeffrey, G. A., *Nature*, 143, 894 (1939). Brown, C. J., Ph.D. thesis, University of Birmingham (1939). Cox, E. G., *Nature*, 154, 84 (1944).

Residual Films of D.D.T.

IN the course of an investigation into the toxicity to houseflies of films of the insecticide D.D.T. deposited upon an absorptive type of wall-board, some observations have been made which may help to explain certain results obtained in field and laboratory tests by other workers.

Pieces of wall-board were sprayed with various concentrations of D.D.T. in 'Pool' burning-oil to give equal deposits of D.D.T. per unit area. After four days at 27·5° C. and 60 per cent relative humidity, flies were confined on the treated surfaces under petri dishes. From the data for toxicity to flies it was clear that, within the limits of the experiment, the highest toxicity was obtained from a given quantity of D.D.T. by applying it at a high concentration.

When the same samples were tested four weeks after treatment, those with the highest concentrations of D.D.T. had increased strikingly in toxicity. Microscopic examination revealed that, on those samples to which the D.D.T. had been applied in high concentration, the areas exposed to flies at the first test had become thickly carpeted with minute crystals of D.D.T. Further investigation has shown that D.D.T. has a great tendency to supersaturate or supercool, this tendency being greater with crude than with pure D.D.T. and greater when the solvent is 'Pool' burning-oil than acetone. Movement of the confined flies is sufficient mechanical agitation to induce crystallization of the relatively poorly toxic gum-like residue, a phenomenon which can also be initiated with a soft paint-brush. If the surface remains undisturbed, crystals do not form for at least several weeks and much of the potential toxicity of the D.D.T. residual film remains latent. The data supporting these observations will be reported more fully later.

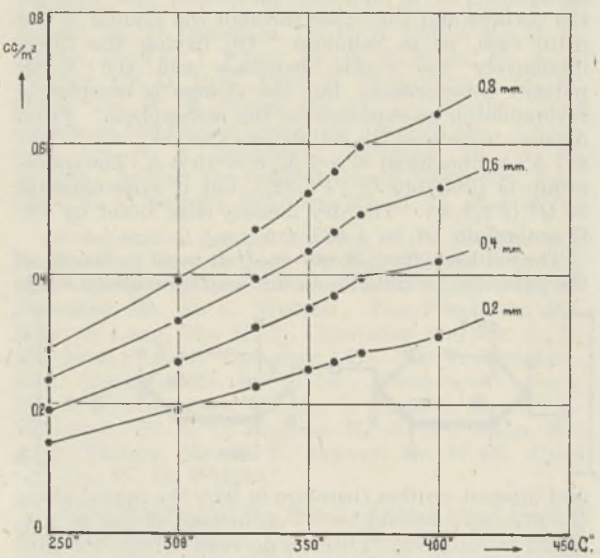
This work forms part of the programme of research of the Pest Infestation Laboratory, and this note is published by permission of the Department of Scientific and Industrial Research.

E. A. PARKIN.
A. A. GREEN.

Pest Infestation Laboratory,
Slough, Bucks.
April 16.

Activated Adsorption of Hydrogen in the Neighbourhood of the Curie Point

IN catalytic phenomena the ferromagnetic metals (iron, cobalt, nickel) possess a special interest. On the other hand, it is also known that adsorption phenomena are closely connected with catalysis. In continuation of systematic work carried out during recent years in this laboratory on adsorption phenomena, we measured the adsorption of hydrogen on nickel sheets between 200° and 400° C. The nickel is thoroughly cleaned by washing it successively with hydrogen and pumping off for several hours at 600° C. at a pressure lower than 10^{-6} mm. Special care is taken with the purification of the hydrogen. The measurements have been made with pressures up to 1 cm. It is found, first, that the equilibrium is very rapidly reached (30 sec.); secondly, adsorption increases with increasing temperature; thirdly, in the neighbourhood of the Curie point (358° C.) the isobars show a very pronounced discontinuity (see graph).



Chevenard[1] and Williams[2] found also by means of measurements on the thermal expansion coefficient of nickel some discontinuities at the Curie point. These discontinuities are, however, too small to explain the phenomena observed by us. It is known that activated adsorption is connected with the electronic state of the metal, and at the Curie point this state undergoes some characteristic modifications.

Finally, our measurements on adsorption isotherms revealed partial reversibility for the adsorption.

A detailed report on these measurements will be published in the *Annales de Physique* (Paris).

A. VAN ITTERBEEK.
P. MARIËNS.
I. VERPOORTEN.

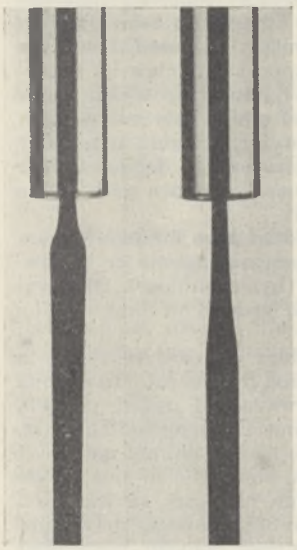
Physical Laboratory,
University of Louvain.
Feb. 23.

[1] *Trav. et Mém. Bur. Inst. des Poids et Mes.*, 17 (1927).
[2] *Phys. Rev.*, 46, 320 (1934).

Elastic Recovery in Capillary Flow

In a previous communication[1] the non-Newtonian behaviour of certain visco-elastic materials, including rubber solutions and soap-thickened mineral oils, was discussed. Experiment had shown that when such liquids flow through a capillary there is a loss in pressure at the tube entrance followed by a uniform fall in pressure down the remainder of the tube. This loss was shown to be large, particularly at high stresses, and if expressed in the form of an end 'correction', sometimes amounted to as much as fifty diameters. The effect was attributed in a general way to the elastic nature of the material since it did not occur in Newtonian liquids or solid-liquid suspensions. In addition, this 'elastic end effect', as it was termed, was found to be related to the recovery or swelling of the column of liquid issuing from the capillary.

Elastic recovery normally starts at the actual capillary end, but it has now been observed that at high stresses, corresponding to velocities of one or two metres per second, recovery is delayed. The delay becomes more pronounced if velocity is increased further, as the accompanying photographs show. All the materials and concentrations so far studied show this phenomenon.



3·7 m./sec. 5·5 m./sec.
Mean velocity.

It was also found that with certain solutions the onset of this delay coincided with an unmistakable 'kink' in the flow curve, indicating a sudden increase in the rate of flow.

It is not possible at this stage to state the exact cause of these anomalies—the delay in recovery and sudden increase in the flow-rate—but several explanations are possible. It might, for example, be due to slip at the tube wall. A more likely explanation, however, involves the question of time. At low velocities recovery is very rapid compared with the downward movement; but at high velocities the liquid may not be able to make any appreciable recovery until it has moved some distance from the tube; hence the delay in the appearance of the swelling.

With normal recovery the swelling is usually very rapid (cf. Fig. 2[1]) and it seems possible that this may react on flow immediately inside the tube, producing a small 'back pressure' tending to restrict the flow. This restriction would be removed when recovery took place well away from the capillary, and we should expect a sudden increase in the flow-rate at the transition. This idea seems to be supported by the fact that the 'kink' is apparent in precisely those materials which show a relatively large recovery (and consequently a large entrance loss); in cases where recovery is relatively small, no appreciable 'kink' occurs.

A. C. MERRINGTON.

6 Redford Road, Horsham,
Sussex. Dec. 29.

[1] Merrington, A. C., *Nature*, **152**, 663 (1943).

Internal Waves in the Sea

I AM just reading with great interest the important and excellent work by H. U. Sverdrup, M. W. Johnson and R. H. Fleming, "The Oceans: their Physics, Chemistry and General Biology" [Prentice-Hall, Inc., New York, 1942. See p. 652 of this issue of *Nature*]. I should like to direct attention to a lapse which I am rather anxious to have pointed out. On page 592 the first observation of internal waves in the sea is attributed to Helland-Hansen and Nansen. The fact is that such waves were discovered in the Great Belt two years before by the nestor of Swedish oceanographers[1], the late Otto Pettersson—well known as the originator of the international organization for marine research—and he also proved their tidal periodicity. Furthermore, on page 600 reference is incidentally made to observations of internal waves in a Swedish fjord which Otto Pettersson is said to have carried out "during 2 months of 1909". As a matter of fact, these observations were continued over several years[2], and—although particular theoretical conclusions which Pettersson inferred are open to serious criticism—the observations themselves are in their method by far the most exhaustive ever made.

These comments may seem to be of minor importance, but since internal waves have, of late, attracted the intense and increasing interest of oceanographers, and since Otto Pettersson himself was from the first aware of the importance of his discovery and took particular interest in it, I think we owe him the justice of acknowledging his priority, at the same time as we recognize the important contributions of Nansen and Helland-Hansen.

V. WALFRID EKMAN.

Gostad, Stockaryd,
Göteborg.

[1] Pettersson, O., "Strömstudier vid Östersjöns portar", *Svenska Hydrografisk-biologiska Kommissionens Skrifter*, 3 (1907). Also in "Ueber Meeresströmungen", *Veröffentlichungen des Instituts für Meereskunde* (Berlin, 1908).

[2] Pettersson, O., "On the Occurrence of Lunar Periods in Solar Activity and the Climate of the Earth", *Svenska Hydrografisk-biologiska Kommissionens Skrifter*, 5 (1914).

IN making the statement on page 592, to which Prof. Ekman refers, "that the first observations of short-period variations which indicated the existence of internal waves were discussed by Helland-Hansen and Nansen (1909)", the authors have in mind the short-period variations observed during the 1893–96 voyage of the *Fram*. Nansen realized that they might be due to waves at the boundary between water-strata of different density, but it was not until 1909 that he and Helland-Hansen, persuaded by their 1900–4 observations in the Norwegian Sea, were convinced of the reality of internal waves.

In the meantime, Otto Pettersson had observed the rise and fall, with tidal periodicity, of the boundary surface between the poorly saline water from the Baltic Sea and the more saline undercurrent from the Skagerrak. Helland-Hansen and Nansen did not acknowledge this contribution although they were aware of it (p. 239; 1909).

Technically, at least, Pettersson's claim for prior discovery is well-founded, but it is obvious that the question was one under wide discussion at the time, and the Norwegian oceanographers would make a strong claim. It is quite possible that Prof. Ekman's own work on 'dead water', published in the results

of the 1893–96 expedition, played a great part in suggesting the correct explanation.

Oceanography has advanced too rapidly in the twentieth century to allow its text-books to include an adequate treatment of historical aspects. It would be a very good thing if a history of the subject could be written, while authorities whose basic contributions have been appearing since late in the nineteenth century can, happily, still be consulted.

G. E. R. DEACON.

Biliverdin as a Pigment in a Fish

IN *Belone belone*, the garfish, the bones, scales and fin rays are of a bright green colour. The chemical nature of this well-known colouring matter has long remained unknown. It cannot be extracted from the tissues in which it occurs by any organic, or neutral, weak acid or alkaline inorganic solvent. But in stronger bases the green scales show a particularly clear transition to yellow, which can be turned back to green again in acids. In at least ten per cent alcoholic hydrochloric acid, the green colouring matter quickly becomes a blue-green in solution and can be separated with chloroform. It gives a clear Gmelin reaction and shows in its insolubility all the typical characteristics of biliverdin.

Thus, a gall pigment has been found in invertebrates for the first time, together with other pigments, as a colouring matter of the integument.

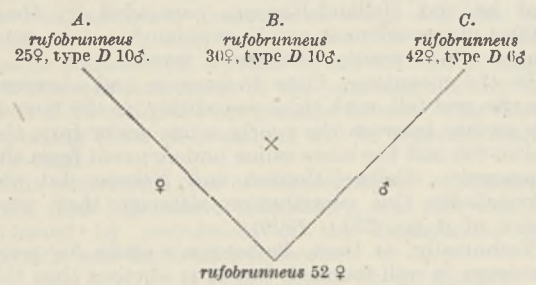
MELAHAT CAGLAR.

Zoological Institute,
University of Istanbul.
Feb. 1.

Genetics of Woodlice

I POINTED out recently[1] that my last brood of *Armadillidium vulgare* (Latr.), var. *rufobrunneus* Cllge., nearly all died. Of the previous brood, the result of a cross between a female of *rufobrunneus* and a male of Howard's type *D*, I obtained the following interesting result. A brood liberated on October 26 consisted of 40 female *rufobrunneus* and 27 males of type *D*. Most of the male specimens have been consumed by the females of *rufobrunneus*. I secured, however, three females impregnated by one of the males of type *D*, and from these I have obtained three broods. All the specimens appeared to be sickly and most of them died.

Later, I placed a specimen of *rufobrunneus* from the brood *A* with a male specimen from brood *C*. The result was a brood of 52 females referable to the variety *rufobrunneus*, as shown below:



If we compare these two series of experiments (*Nature op. cit.*), and the present record, the following facts seem clear.

(1) That the female of the variety *rufobrunneus* crossed with the male of Howard's type *D* in the first generation produced more females than males; in the second generation, there were more males than females, and in both cases all were referable to type *D*. In the third generation we find no specimens referable to type *D*; all belong to variety *rufobrunneus* and all are females.

(2) In the second experiment, described above, the variety *rufobrunneus* dominates in three separate broods and the bulk of the progeny were females, namely, 97 females and 16 males. In the final brood all the specimens were referable to the variety *rufobrunneus* ♀.

(3) It would appear from these experiments that the variety *rufobrunneus* was a dominant form, and while the type *D* makes its appearance, in only one instance did it exceed the number of females.

WALTER E. COLLINGE.

The Hollies,
141 Fulford Road, York.

[1] *Nature*, 154, 797 (1944).

Colour and Growth of Hair in Rabbits

HADDOW *et al.*[1] have recently reported that the growth of hair on the rat appears to take place in a series of waves symmetrically disposed about the longitudinal axis. They support this view by studying the disposition of a flavin dye, which, after injection, colours the hair of albino rats in a pattern corresponding to the most rapidly growing hair. They record the areas of regeneration of depilated hair and show that the blood capillaries are most dense in the areas of rapid growth.

Rabbits have been depilated here for many years in order to study either vaccinia lesions or the behaviour of 'diffusing factor' (hyaluronidase). Observations made concerning the growth of hair on the rabbit may be of interest.

Hair growth on the rabbit appears to follow a similar course to that reported for the rat. In rabbits with coloured hair the waves of rapid growth, disposed symmetrically about the longitudinal axis, can be observed on the depilated animal as raised coloured areas varying from about 0·5 to 5 cm. wide and usually stretching from the ears to the hind quarters. Close examination of these areas shows that they are coloured because they contain pigmented hair shafts. When the hair has ceased active growth the proximal half of the shaft is white, pigment being restricted to the distal part. Hence the skin in regions of restricted growth appears white. Varieties of rabbit such as the Flemish Giant have hair, each shaft of which has bands of different colour. These bands always appear in the same order, and hence by noting the colour of the shafts just emerging from the skin an estimate may be made of the direction of the growth wave. The younger hair is always on the ventral edge of the wave, and from this it is deduced that the waves spread from the dorsal to the ventral surface of the animal. In albino rabbits rapid growth of hair seems to occur in raised hyperæmic areas in which the pink colour suggests dilatation or abundance of skin vessels. These areas are 'spongy' if injected with a needle. Hyperæmia and thickening of the skin in these areas of rapid hair growth is always more pronounced on the ventral edge, the whole area appearing as an escarpment facing downwards. In adult animals these waves of hair growth

usually occur in spring and autumn. Young growing animals show areas of rapid hair growth more frequently and do not show the same seasonal incidence. No such areas have been noted on depilated guinea pigs.

Hair growth on the rabbit may be artificially modified by agents that induce localized hyperæmia. For example, in animals which have recovered from vaccinia lesions the hyperæmia engendered by the vaccinia pocks persists and a strong growth of hair frequently occurs exactly over the sites of the healed vesicles. This hair appears to be quite normal except that it is surrounded by relatively bare areas on which no vesicle, and therefore no hyperæmia, has occurred. Similar growth takes place after the intracutaneous injection of small doses of diphtheria toxin.

These observations correlate well with the experimental results of Haddow *et al.* that "by far the greatest density of capillaries occurs in those positions which correspond to the advancing edge of the growing hair—" and that "it is likely that the pigment (the flavin dye) enters growing areas partly because these are the only ones in sufficiently active interchange with the general circulation". From the observations on the rabbit reported here it appears likely that both rapid growth and natural pigmentation of the hair shaft in this animal are correlated with local increased blood supply to the hair follicles.

C. W. HALE.

Lister Institute of Preventive Medicine,
Elstree, Herts. April 14.

[1] Haddow, A., Elson, L. A., Roe, E. M. F., Rudall, K. M., and Timmis, G. M., *Nature*, 155, 379 (1945).

Feeding Twitch Rhizomes as an Alternative to Hay

TWITCH, or couch, grass (*Agropyron repens*) is among the common weeds which are difficult to eliminate. It is widespread, and persistent 'cleaning' of the soil seldom eliminates the whole stock; even more serious is the widely dispersed pest in hedge banks and other uncultivated plots. It is not only distributed by air-borne seeds, but it also extends rapidly by the creeping roots or rhizomes.

The roots or rhizomes are palatable and pigs are known to be fond of them. They also proved palatable when fed to domestic rabbits.

The chemical composition of dried roots of twitch showed them to be somewhat similar to meadow hay of good and lower-grade qualities; the rhizomes contain less fibre and somewhat less protein and mineral matter but, compared with cereal straw, rhizomes appear to be superior in protein and carbohydrate content:

COMPOSITION[1] SHOWN BY ANALYSIS.

	Dry Matter	Protein	Oil	Carbohydrates Sol.	Fibre	Ash
Twitch rhizomes (dried)	85·0	5·0	0·6	56·5	19·8	3·1
Meadow hay, poor	85·7	7·5	1·5	38·2	33·5	5·0
,, ,, good	85·7	9·7	2·5	41·0	26·3	6·2
Oat straw, winter	86·0	1·9	1·5	43·1	34·6	4·9
,, ,, spring	86·0	2·9	1·9	42·4	33·9	4·9

The shortage of hay supplies, following the 1944 drought during the growing season, has accentuated the need for hay substitutes[2,3].

Several palatability tests proved that rabbits ate the rhizomes more readily than rough grass hay and it was therefore decided to carry out a small feeding-trial.

Feeding Rhizomes. Eighteen resting female rabbits of Beveren type were divided into two similar groups. All but one in each group were yearlings; the other was approximately three years old. The basal maintenance diet consisted of succulents, green-food (of variable quality, according to seasonal supply, but similar for both groups) and/or roots, supplemented by meal mash containing minerals and cod liver oil. Water was provided. The control group received rough grass hay, cut from poultry runs, while the other group was given dried twitch rhizomes of common couch or twitch grass.

The hay supply consisted of hard fescue and tall oat grass, cocksfoot, smooth-stalked meadow grass, fiorin, Yorkshire fog and a trace of clover. The species predominance was in that order.

The rhizomes were harrowed out and then forked over and air dried. They were relatively clean in appearance and were stored and fed in this state for the first eighteen weeks of the trial. During the remaining period, freshly dug roots were used; but owing to excessive soil adhering to them they were washed and air dried, although the time of year (November) precluded complete drying of this supply.

During a preliminary week, it was found that average daily consumption rates were, hay 0·75 oz. and rhizomes 1·06 oz. Therefore the supply was restricted, averaging 0·7 oz. per head per day in each group.

Throughout the period of feeding unwashed and dried rhizomes, this group maintained a slight advantage in live weight over the controls fed on hay. After the change-over to freshly dug rhizomes the twitch group continued to give slightly heavier body weight in all but three weeks in spite of the reduced dry matter intake.

At the conclusion of twenty-five weeks of feeding twitch grass rhizomes as a substitute for hay the average live weight had increased in the hay group by 3·70 oz., and in the rhizomes group, 4·91 oz.

The condition of the animals was good, although they were moulty at the commencement, and improved as they moulted through. Health was excellent, with one exception in each group. An older one in each group died in the tenth week on twitch, and eighteenth week on hay. The respective post-mortem examinations by the veterinary officer revealed nephritis (twitch) but examination for sand was negative; and abscesses on the spleen and liver (hay). The rest of the stock remained free from symptoms of disease. The coats appeared to be slightly silkier on rhizomes than hay at the end of the seventh week; but after the feeding of freshly dug rhizomes the tendency appeared to be reversed. While there were differences between individuals within groups, the differences between groups were not outstanding, and appeared to depend largely on the stage of the moulting process.

Summary. Air-dried twitch grass rhizomes, either washed or otherwise, were found to be palatable to domestic rabbits. The rhizomes were less bulky than an equal weight of rough grass hay and were eaten more quickly, and they proved to be a satisfactory substitute for hay when fed in maintenance rations for 175 days.

W. KING WILSON.

Harper Adams Agricultural College,
Newport, Shropshire.

[1] *Min. Agric. Bull.* No. 124 (1942).
[2] Wilson, W. King, *Nature*, 147, 796 (1941).
[3] Wilson, W. King, *Harper Adams Util. Poultry J.*, 29, 45 (1944).

Non-luminous Flame Gases

PROF. W. T. DAVID and his co-workers have published a moving-film record of the passage of flame gases along a glass tube[1]. Such records have frequently appeared elsewhere[2], but the explanation given by the writers of the letter, namely, that "the flame gases, although luminous after the early stages of flame-front travel from the igniting spark, suddenly become non-luminous after further travel (due apparently to a sudden change in the mode of combustion in the flame-front)" is a mis-reading of the photograph.

The apparent luminosity persistence after the spark has passed, and behind the flame front, is due to the elongation of an expanding ellipsoidal shell of flame, so that the later luminosity is that of freshly ignited gas. A detailed description and explanation of such records was first published in 1928[3].

W. PAYMAN.

Safety in Mines Research Board,
Research Station,
Harpur Hill,
Buxton, Derbyshire.

[1] *Nature*, 155, 273 (1945).
[2] See, for example, Ellis, *Fuel in Science and Practice*, 7, 409 (1928).
[3] Payman, *Proc. Roy. Soc.*, A, 120, 90 (1928).

THE long duration of the "later luminosity" or "after-glow" militates against Dr. Payman's view; and, indeed, its incorrectness is demonstrated by Dr. Ellis's instantaneous photographs (see, for example, *Fuel in Science and Practice*, 7, No. 9, 410, photographs Nos. 8–10).

W. T. DAVID.

Engineering Department,
The University, Leeds, 2.

An Illusion of Size

IF one looks at two nickel threepenny bits, a brand new one and a mat old one, with reduced illumination, the old one appears considerably bigger. The difference is striking if the illumination is correctly chosen. Out of fifty people, two only did not see the phenomenon immediately; even those two recognized it when the experiment was repeated. Older people realized it quicker than younger ones. Colour does not play any part, as the same difference is recognizable with shillings.

The phenomenon is obvious with a neutral or dark background, but is not provoked, or it may be inverted, when the two objects of different light value are viewed against a white background. Here the new coin sometimes appears bigger than the old one, when light is reduced.

The only explanation of the effect which I can offer is as follows: The old coin appears fogged when light is reduced, while the shining new piece of metal reflects light and is seen sharply. We are accustomed to linking a greater distance with a fogged object and therefore to over-estimate its size. Thus the moon seen through thin clouds appears bigger than a clear shining one; and misty hills seem to be at a greater distance than those sharply outlined and the size of the latter is correspondingly undervalued (Luckiesh[1]).

This explanation is supported by the fact that the difference of size is more impressive after some seconds, as the phenomenon is psychological and not a purely physical one. If we use a white background the experiment fails. It seems that there is not sufficient light reduction to create the adequate dimness of the old coin, while irradiation may interfere in the case of the new one. Using Ostwald's colour papers as background, I found that variation of colour does not influence the intensity of the size illusion, but that different greys of the $A - P$ series produce it sufficiently, the darker greys being no better than the middle ones.

ARNOLD LOEWENSTEIN.

Department of Ophthalmology,
University, Glasgow.

[1] Luckiesh, "Visual Illusions", 166 (New York, 1920).

Avoidance of Obstacles by Bats

MR. OLIVER G. PIKE, in his interesting article on bats in *Nature* of January 27, suggests that these creatures avoid obstacles in the dark by means of "a sense of which we know little, and to which it is very difficult to give a name, but which appears to be connected with the 'earlet' . . . and . . . the 'horseshoe'. . . . These organs, *combined with their keen sense of hearing*, assist them to dodge all obstructions, and to find insect food while flying in the dark" (my italics).

The phrase in italics contains the key to the problem. Recent work in America by Galambos and Griffin[1,2,3] has shown that the mechanism of obstacle-avoidance by bats depends on their utterance of supersonic cries, the echoes of which from insect prey or obstructions are picked up by the cochleæ. The 'stereoscopic hearing' resulting from central analysis of these supersonic echoes compares very favourably with binocular vision. It is interesting to reflect that a biological application of principles now widely used for the detection of military targets has thus been revealed.

A. K. MCINTYRE.

R.A.F. Physiology Laboratory,
at Royal Aircraft Establishment,
South Farnborough, Hants.

[1] Griffin, D. R., and Galambos, R., *J. Exp. Zool.*, 86, 481 (1941).
[2] Galambos, R., and Griffin, D. R., *J. Exp. Zool.*, 89, 475 (1942).
[3] Galambos, R., *J. Acous. Soc. Amer.*, 14, 41 (1942).

Marine and Other Biological Laboratories

PROF. J. H. ORTON'S article[1] contains certain inaccuracies as regards the status of marine biological laboratories in Scotland. First, the Millport Laboratory is not attached to the University of Glasgow, but is the property of the Scottish Marine Biological Association—an organization parallel with the Marine Biological Association of the United Kingdom to which the Plymouth Laboratory belongs. The Millport Station receives welcome aid from all the Scottish universities, more particularly Glasgow.

Further, it might be pointed out that "St. Andrews, Nigg" has no meaning. The University of St. Andrews owns the Gatty Laboratory at St. Andrews, but the former station at Nigg was operated by the Fishery Board for Scotland and not by the University of Aberdeen.

RICHARD ELMHIRST.

Scottish Marine Biological Association,
Marine Station, Keppel Pier, Millport,
Isle of Cumbrae.

[1] *Nature*, 155, 550 (1945).

THE KELP TRADE

By DR. V. J. CHAPMAN
Botany School, Cambridge

THE formation of the Scottish Seaweed Research Association last year stimulates one to inquire into the somewhat chequered history of what is known as the kelp industry. At one time this assumed considerable importance in Europe and afterwards spread to the United States and Japan, the last-named country producing in 1929 some 7 per cent of the world's iodine entirely from seaweeds. The word 'kelp' itself properly refers to the burnt ash of seaweed, but has since been extended to include the living plants.

The beginnings of the kelp industry are associated with the need for soda in the manufacture of glass and the glazing of pottery. Some time in the seventeenth century the kelp industry had its origin in France, and soon became so important that Louis XIV gave the Royal Company of Glass Manufacturers in Paris the sole privilege of cutting annually between certain fixed dates all the suitable seaweed along the coast of La Hogue. This had to be revoked because of local agitation among the farmers, who from time almost immemorial had used the seaweed as manure on the land. Its use in this fashion had enriched the coastal lands to such an extent that they were known as the *Ceinture Dorée*.

Soon after the turn of the century the kelp trade began to spread, first to Ireland, thence to Scotland, the Orkneys and to Norway. In Scotland the first cargo left the Hebrides in 1722 and the trade then started to flourish so much that by 1800 Scotland was said to have produced about twenty thousand tons annually. This is probably an over-statement; it is likely that twelve thousand tons is more accurate.

In the early days of the industry the principal seaweeds used by the kelp burners were the bladder-wracks (*Ascophyllum* and *Fucus* species) because they contained the highest proportion of soda. The manufacturers sought it as a less expensive substitute for a material called barilla soda which had to be imported from Spain. There came a time, though, when the duty on barilla was reduced and then soon afterwards the mineral deposits of Stassfurt were discovered. Both these events, as might be expected, almost sounded the death-knell for kelp; but reprieve was at hand. This came in the discovery of iodine, and in the further discovery that the oarweeds (species of *Laminaria*) were rich in this new element. The first factories for the extraction of iodine were built in France soon after 1820, and by 1843 the trade was once more flourishing. This stimulus given to the kelp trade by the discovery of iodine did not persist for long, because in 1873 the discovery of the Chilean resources dealt the industry a blow from which it never recovered.

Both in France and the Orkneys there was opposition at the start to kelp-burning because it was thought that the fisheries would be damaged. In the Orkneys a number of trials even took place. Later, however, when the industry formed a livelihood for sixty thousand people, the old Highland toast 'a high price to kelp and cattle' was witness of the change of spirit.

When bladder-wrack was the principal source of kelp the right to cut it was a jealously guarded privilege retained by those whose land adjoined the beach, and in France a number of decrees laid down the regulations. Thus we find that the rockweeds or *goémon de rive* are described as those which are attached to the ground and may be reached dry-shod at low water of spring tides, but we go on to learn that the regulation dry-shod means that the cutter can enter the sea *jusqu'à la ceinture*!

In France the oarweeds were cut by special workers known as *soudiers* or *goémonniers* who had to obtain a licence, but in other countries there were often no restrictions and the submarine forests of the sea were open to all who cared to carry out the arduous work. A satisfactory method of harvesting these growing weeds is indeed one of the main problems still confronting present-day operators in Europe. Cast weed, however, seemed to come into a different category: it was evidently considered that this was more or less common property, and in order to ensure that no quarrels should arise from its collection, each town, hamlet or region drew up its own rules. Thus in the Orkneys when a 'brook of ware' was thrown ashore the laird's factor divided the cast into a number of lots, and each crofter took so many lots according either to his acreage or his rent. The actual site of the lots was settled by ballot. In France much the same practice was followed. In the Isle d'Ouessant, after a gale had blown a good cast ashore, it was the privilege of the oldest inhabitant to mark it out into equal portions. When this was completed each family was permitted to take away as many lots as there were members in the family, but were only allowed to collect them "when the lighthouses were extinguished".

The old method of burning the dry seaweed in open kilns was wasteful as much of the iodine was lost to the atmosphere. Indeed, Cauer[1] has maintained that the high iodine *milieu* of central Europe is directly attributable to this fact. This loss and the impossibility of drying seaweed in the winter led to a search for an improved extraction process. The chemist E. C. Stanford was most active, and he first proposed the char or distillation process[2]. Stanford naturally met considerable and determined opposition to his new method from the conservative kelpers. In a great effort to try to convince them that his technique was superior, he arranged that one of the most experienced crofters should pit himself in a test against him (Stanford), and there was no doubt that Stanford produced the better product. But the Hebridean crofters are not thus to be readily daunted, and so the old kelper turned to him and said, "I have been making kelp for fifty years and more, and am I to be taught by a young Sassenach with no beard on his face to speak of!"

Later Stanford invented the lixiviation process, which is of considerable importance because by this technique he obtained alginic acid. This substance, discovered by Stanford, is likely to prove the most important product to be obtained from the brown algæ[3]. A number of factories were built but the laboratory processes just described could not be made to work satisfactorily on a commercial scale and much money was lost; this contributed to the collapse of the industry as a whole. It is, one hopes, partly to avoid a repetition of this error that the Scottish Seaweed Research Association has been formed.

Variants of both the char and lixiviation processes have been evolved but none of these appears to have been more successful than the originals. A Russian technique is, however, of more than passing interest. The Russians are not employing the oarweeds but instead a red seaweed, *Phyllophora nervosa*, which grows

abundantly in the Black Sea and is very rich in iodine. Water containing the chopped alga is electrolysed at increasing potentials, iodine separating out at the lowest, then bromine and finally chlorine at the highest. The solution is then concentrated and further electrolysis yields mannite and alginates.

In the past mistakes have also been made by scientific workers in not paying sufficient attention to (*a*) season of the year, (*b*) type of locality, (*c*) age of material, (*d*) proportion of stipe to lamina in the sample. Here again the S.S.R.A. will, it is hoped, see that these gaps are adequately filled. If the kelp industry in a new form can be started again it should go far to improve the lot of the crofters in the Highlands and Isles of Scotland if their natural prejudices can be overcome. The poverty of these people has to be seen to be believed: the habitations compare unfavourably with many of our slums, and overcrowding in small, ill-lit and badly ventilated cottages with their heavy peat smoke atmosphere is the rule rather than the exception. Any effort, therefore, that will improve their lot is to be welcomed.

[1] Cauer, H., *Biochem. Z.*, 299, 69 (1938).
[2] Stanford, E. C., *J. Soc. Arts*, 10, 185 (1862).
[3] Delf, E. M., *Nature*, 152, 149 (1943).

GENETICS IN RELATION TO DISEASES OF ANIMALS AND PLANTS

AT a joint meeting of the Association of Applied Biologists and the Genetical Society, held in London on March 23, the problem of the "Genetic Relations of Plants and Animals to their Pests and Diseases" was discussed.

Dr. C. D. Darlington (president of the Genetical Society) opened the proceedings by emphasizing the two fundamental facts that all species of animals and plants vary genetically in their power of resistance to, or defence against, disease; and that all disease organisms vary genetically in their power and mode of attack, and in their resistance to our control methods. Variability is the rule rather than the exception or nature, but crop and stock improvement in the last fifty years had tended to reduce variability within the different cultivated races even to the extent of producing, at times, a homozygous pure line. One of the problems of the future must be to introduce new variation into the cultivated forms. He also discussed the power of plants to produce antibodies to a virus, and considered that the recent work of J. M. Wallace (*J. Agric. Res.*, 69, 187) showed that antibodies to a virus are produced by tobacco and that they can propagate themselves in the tomato plant, which cannot itself develop them.

Dr. J. Hammond dealt with constitution in cattle in relation to pests and diseases, particularly as illustrated by the introduction of European cattle into the tropics. There they are particularly susceptible to local pests and diseases to which the native or other tropical cattle are comparatively resistant. European cattle have a higher level of tick infestation than the zebu, possibly due to their longer hair and higher body temperatures. There is no evidence of any immunity to tick fever in the zebu, but the resistance to its effects is much higher than in European races, and first crosses come much nearer to the zebu. Body temperature and respiration-rate have been measured in crosses and back-crosses between zebu and European cattle under tropical conditions. Milk production and growth run parallel with their resistance to tick fever, and there is little doubt that they are all dependent on differences in physiological constitution connected with heat regulation at high air temperatures. New tropical breeds—for example, the Santa Gertrudis and the Philamin—are being formed to combine the productive powers of European beef cattle with the heat-, tick- and disease-resisting qualities of the zebu.

Michael Pease discussed the inheritance of disease resistance in poultry. He said that it had been claimed that the virtual disappearance of fowl paralysis in recent years had been due to selective breeding. In the Cambridge flock the disease was first noticed in 1930; increased to an alarming peak in 1935; and thereafter declined to negligible proportions in the war years. This was typical also of other parts of the country. In spite of this, analysis of the breeding results year by year gave no evidence that inheritance played any part in the incidence of the disease. With regard to non-specific disease in poultry it was widely held that this was due to breeding from too young birds. A statistical analysis of chick and adult mortality at Cambridge had shown that the determining factor was not the age of the mother, but whether she died during the breeding season or survived. Mothers which died early during the season left a progeny with an excessive death-rate. The age or death of the cock was without any apparent effect.

Dr. J. S. Carr discussed the heritable susceptibility to cancer in the domestic fowl. The incidence is high in all breeds throughout the world, and it is generally considered that the majority of cases are due to the action of carcinogenic viruses, of which a number are known. Using Rous No. 1 Serum as a test virus and 6–8-week old chicks as host, it was possible to show that the main factor determining known growth was the genetic constitution of the host. From a flock of Brown leghorns it was found possible to build up by selection a line with very high resistance to this virus. The line was also resistant to other carcinogenic viruses and to a certain extent to chemically induced tumours.

Dr. William Black discussed the inheritance of resistance to blight (*Phytophthora infestans*) in the potato. A wild polyploid (*Solanum demissum*) was used as the source of resistant genes. Three strains of blight, *A*, *B* and *C*, were isolated and four resistant phenotypes were differentiated as follows:

(1)	Plants immune from	*A*, *B* and *C*.	
(2)	,,	,,	,, *A* and *B* but not from *C*.
(3)	,,	,,	,, *A* and *C* but not from *B*.
(4)	,,	,,	,, *A* but not from *B* and C.

As all these were immune from *A* it appears that this strain is less virulent than the others, but the difference in virulence between *B* and *C* appeared to be qualitative rather than quantitative. A series of parallel tests of derivatives of three species, *Solanum rybinii*, *S. demissum* and *S. tuberosa*, led to the conclusion that immunity from *A* and *B* is controlled by two major genes, *Ra* and *Rb*. Plants carrying *Ra* are immune from the *A* strain, while plants carrying *Rb* are immune from both *A* and *B*.

Dr. G. Cockerham discussed the genetical aspects of resistance to potato virus and particularly the problem of 'hyper-sensitiveness' which causes such rapid death of the tissues round the point of infection that the virus is unable to spread. This results in what he

calls 'field immunity'. A single dominant gene *Nx* produces hyper-sensitiveness to several strains of virus *X* but not to other aberrant strains. Another gene *Na* determines hyper-sensitiveness to virus *A*, and in each of six cultivated varieties this is closely linked with N_x. In the variety South-Esk, however, the two genes are independent. Still another gene N_c determines hypersensitiveness to virus *C* which is a strain of virus *Y*. No cultivated variety of potato is hypersensitive to virus *Y*, but five clones of three different 'wild' species showed characteristic responses when infected in the laboratory. Dr. Cockerham believes that 'hyper-sensitiveness' is a character of significant value in virus control.

Prof. T. J. Jenkin gave a short account of work in connexion with disease and pest resistance at the Welsh Plant Breeding Station at Aberystwyth, which is concerned chiefly with the production of new varieties of oats, clover and herbage grasses. By selection from mixed population a variety of oat, *S.* 75, has been produced which is highly resistant to smut (*Ustilago*), and the white winter oat variety, *S.* 81, is one of the most resistant to eelworm. In clover, special attention has been paid to finding strains resistant to clover rot (*Sclerotina trifoliorum*) and eelworm (*Tylenchus devastatrix*). Here the choice of breeding material is far wider than in oats owing to the heterogeneity of the crop and the heterozygosity of individual plants.

In the discussion which followed the principal speakers, Prof. W. J. B. Riddell directed attention to the effect of the different varieties of *Pneumococcus* causing pneumonia. In Glasgow, type II occurred with higher frequency than in Manchester, where type I was the most common. Since the introduction of chemotherapy, type II had relatively increased in Glasgow.

Dr. K. Mather mentioned the work of Lindstrom and his pupils on the bacterial wilt of maize. In this case the bacterium increases in virulence by passage through a resistant inbred line of maize, but decreases in virulence by passage through a susceptible line. In mixed inoculations the virulent strain is selectively favoured by resistant maize and the avirulent by susceptible lines.

M. A. Crane discussed the effect of the use of 'clonal' crops and suggested that some of the dangers might be avoided by the regular production of short-lived clones or by the regular production of F_1 families which are sufficiently uniform for commercial requirements. Virus infection upsets uniformity even in clonal crops. In some vegetatively produced plants the position has now been reached when as much care, or more, has to be given to the nursing of old clones as to their cultivation.

F. C. Bawden did not agree that present available evidence proved the existence of virus antibodies in plants.

Dr. H. W. Howard said that at Cambridge experiments had been carried out to obtain potatoes resistant to blight, using *S. demissum* as the source of immunity, with results very similar to those obtained by Dr. Black at Edinburgh. In F_6 and F_7, however, there was some indication of the effect of modifying genes being of importance. He considered that the genetics of the parasite (*P. infestans*) needed more investigation. Strains from single spores had not changed their virulence and the origin of new strains may be due to sexual reproduction.

R. Stenton suggested that the ratio of diseased individuals in a mixed population of unknown genetic constitution might be found to be proportional to the number of recessives present.

Dr. C. B. Williams (president of the Association of Applied Biologists), in summing up, re-emphasized the importance of keeping a high level of variability in the host plants or animals as a protection against possible new diseases in the future. He gave a short account of work recently carried out by Dr. S. C. Harland in Peru on the selection of cotton. Harland started with a very large number of plants tested individually for a small number of commercially valuable characters, and selected for these only, leaving all other characters as variable as possible. He avoids all self-fertilization which produces a large proportion of homozygotes in all characters both visible and invisible. C. B. WILLIAMS.

ARCHÆOLOGICAL EXPLORATION IN SOUTH AFRICA

SEVERAL interesting articles on archæological topics have been published recently in South Africa. Prof. van Riet Lowe and Prof. H. Breuil have been studying a number of Stone Age sites in southern Mozambique, not so far from Lourenço Marques[1,2]. It is true that both reports are very much of an interim nature, and that, except for a page of pottery profiles in one of them, they are unillustrated; but they are important, for enough has been found to show that, archæologically speaking, the area is going to prove of very significant interest. Early palæolithic finds, including some of a Clacto-Abbevillian facies, occur along the foot-hills of the main mountain chain and in the river valleys. At the time when their makers were alive, it seems that the sea coast lay farther inland than it does to-day. Later Stone Age industries occur nearer the present shore-line.

Mr. B. D. Malan, of the Archæological Survey, has issued a handy little instruction pamphlet for the use of would-be excavators[3]. Of course, a pennyworth of practice *under supervision* is worth pounds of theory, but there is room for the latter, too. It is perhaps a pity that no 'tips' for studying rock-shelter paintings and rock carvings are given.

Prof. van Riet Lowe's notes on the laws in South Africa governing archæological and vertebrate palæontological research[4] will be read with mixed feelings. On one hand, certain classes of sites are limited in number, and once spoiled by well-meaning but untrained amateur investigators their evidence is for ever lost. On the other hand, it is not too much to say that most of our archæological knowledge to-day has been due to the devoted efforts of amateurs in the past. Many an amateur excavator is as good, if not better, than his professional *confrère*. To have a paid job as a prehistorian, whether in a Government department or at a university or in a museum, does not thereby endow the holder with the attributes necessary for a really good observer in the field. If regulations are made too tight, the amateur's interest in the subject tends to flag and his intellectual energy to be transferred to other fields. As a result the subject ceases to attract the general public, and a 'hobby subject' needs public interest if it is to continue to progress. In South Africa, the law permits surface finds to be freely collected; but certain types of sites (sealed deposits) are taboo, and so is the "removal and export of vertebrate fossils", and many

official forms have to be filled in before they can be touched by the would-be investigator. Maybe this is a right move, if it can be enforced. Otherwise sites will be stripped by collectors and no records kept. Then indeed the evidence will be totally lost to science.

These problems equally apply to Great Britain. We must face the risk of total loss of valuable evidence due to ignorant amateurs, or the stifling of nearly all amateur effort by bureaucratic control: these are the twin horns of the dilemma. Probably the best solution lies in the education of the local archæological societies and the growth of a public opinion which would ensure that the local society is approached for expert help before any amateur attempts are made to tackle a serious excavation. But even this is not quite so simple as it sounds.

M. C. BURKITT.

[1] "First Impressions of an Archæological Tour of the Southern Extremity of the Colony of Moçambique". By Prof. C. van Riet Lowe and Prof. Henri Breuil. (Imprensa Nacional de Moçambique, 1944.)

[2] "A Contribution to the Prehistory of Moçambique". By Prof. C. van Riet Lowe. (Imprensa Nacional de Moçambique, 1944.)

[3] "Excavation Method in South African Prehistoric Caves". By B. D. Malan. *South African Museums Association Bulletin*, Dec. 1944.

[4] "The Position of Archæological and Palæontological Research in Relation to Law". By Prof. C. van Riet Lowe. *South African Museums Association Bulletin*, Sept. 1944.

FORTHCOMING EVENTS

Tuesday, June 5

ROYAL ANTHROPOLOGICAL INSTITUTE (21 Bedford Square, London, W.C.1), at 1.30 p.m.—Prof. A. R. Radcliffe-Brown: "African Gods and Christian Saints in Brazil" (postponed from May 8).

Wednesday, June 6

SOCIETY OF CHEMICAL INDUSTRY (NUTRITIONAL PANEL) (at Chemical Society, Burlington House, Piccadilly, London, W.1), at 2.30 p.m.—Dr. D. P. Cuthbertson: "Protein Hydrolysates: their Preparation and Clinical Uses".

ROYAL ENTOMOLOGICAL SOCIETY (41 Queen's Gate, London, S.W.7), at 3.30 p.m.—Dr. A. G. Hamilton: "Further Studies on the Relation of Humidity and Temperature to the Development of African Locusts".

Thursday, June 7

THE LINNEAN SOCIETY (joint meeting with the ZOOLOGICAL SOCIETY) (at the Linnean Society, Burlington House, Piccadilly, London, W.1), at 4.30 p.m.—Dr. C. Leighton Hare: "Some Features of the Structure and Life-history of *Eriocaulon septangulare* With. and their Bearing on its Geographical Distribution"; Dr. A. Tindell Hopwood: "Contributions to the Study of some African Mammals. (3) Adaptations in the Skeleton of the Fore-limb of Lion, Leopard and Cheetah".

Friday, June 8

ROYAL ASTRONOMICAL SOCIETY (Burlington House, Piccadilly, London, W.1), at 4.30 p.m.—Discussion on "Extra-Galactic Nebulæ": among the speakers will be: Dr. A. Hunter, on "The Observational Details of the Resolution of Extra-galactic Nebulæ into Stars", and Mr. J. H. Reynolds, on "The Apparent Distribution of the Extra-Galactic Systems and the Validity of the Magnitude-Scale".

ROYAL INSTITUTION (at 21 Albemarle Street, London, W.1), at 5 p.m.—Lord Moran of Manton: "Courage and Fear".

PHYSICAL SOCIETY (at the Physics Department, Imperial College, London, S.W.7), at 5 p.m.—Demonstrations.

Saturday, June 9

BIOCHEMICAL SOCIETY (at the Institute of Physiology, University of Glasgow), at 11.30 a.m.—Scientific papers.

INSTITUTE OF PHYSICS (ELECTRONICS GROUP) (in the Fyvie Hall, The Polytechnic, 309 Regent Street, London, W.1), at 2.30 p.m.—Discussion on "Some Aspects of High Vacuum Technique" ("Glass-to-Metal Seal Design", introduced by Mr. W. J. Scott, and "High Vacuum Pumps", introduced by Dr. R. Witty).

APPOINTMENTS VACANT

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

LECTURER IN THE DEPARTMENT OF PHYSIOLOGY AND BIOCHEMISTRY, King's College, Strand, London, W.C.2—The Secretary (June 8).

LECTURER IN APPLIED MATHEMATICS at King's College, Newcastle-upon-Tyne—The Registrar (June 9).

ASSISTANT LECTURER IN PHYSICAL AND INORGANIC CHEMISTRY at Queen Mary College (University of London)—The Acting Registrar, Queen Mary College, c/o King's College, Cambridge (June 10).

AGRICULTURAL TRAINING OFFICER to organize training in agriculture of persons released from war service—The Executive Officer, Holland War Agricultural Executive Committee, 15 Market Place, Boston, Lincs. (June 16).

LECTURER IN ELECTRICAL ENGINEERING at Kendrick Technical College, West Bromwich—The Director of Education, Education Offices, Highfields, West Bromwich (June 16).

SUB-LIBRARIAN at Bedford College (University of London), Regent's Park, N.W.1—The Secretary (June 20).

LECTURER in charge of the DEPARTMENT OF BOTANY at University College, Leicester—The Registrar (June 20).

LECTURER IN MECHANICAL ENGINEERING at Brighton Technical College—The Education Officer, 54 Old Steine, Brighton, 1 (June 23).

PRINCIPAL of Nottingham and District Technical College—Acting Clerk to the Governors, Education Office, South Parade, Nottingham (June 30).

LINACRE PROFESSOR OF ZOOLOGY AND COMPARATIVE ANATOMY, University of Oxford—The Registrar, University Registry, Oxford (July 7).

SECRETARY OF THE ROYAL GEOGRAPHICAL SOCIETY—The Honorary Secretary (July 31).

PROFESSOR OF AGRICULTURE and also a READER IN PHARMACY in the University of Sydney—The Registrar (six copies of applications, stating age, experience, publications, medical certificate and recent photograph are required) (August 18).

LECTURER IN SOCIAL ANTHROPOLOGY in the University of Edinburgh—The Secretary (September 30).

PROFESSOR OF BOTANY, a PROFESSOR OF ECONOMICS, and a SENIOR LECTURER IN ZOOLOGY, at Auckland University College (University of New Zealand)—The Secretary, Universities Bureau of the British Empire, c/o University College, Gower Street, London, W.C.1.

PHARMACIST for the Northern Rhodesia Government Health Department—The Secretary, Overseas Manpower Committee (Ref. 1252), Ministry of Labour and National Service, York House, Kingsway, London, W.C.2.

BOTANIST for the Intelligence Section of the Plant and Animals Products Department of the Imperial Institute, London, S.W.7—The Establishment Officer.

LECTURER IN BIOLOGY (woman) at Edge Hill Training College, Ormskirk (now at Bingley, Yorks)—The Principal.

REPORTS and other PUBLICATIONS

(not included in the monthly Books Supplement)

Great Britain and Ireland

Royal Institute of Chemistry of Great Britain and Ireland. Twenty-seventh Streatfeild Memorial Lecture: Modern Methods of Food Preservation. By Osman Jones. Pp. 30+6 plates. (London: Royal Institute of Chemistry of Great Britain and Ireland, 1945.) [55

Journal of the Society of Glass Technology. Transactions, Vol. 28, No. 129: XI. Coloured Glasses, Part 3: The Colours Imparted by the Non-metallic Elements; Sulphur, Selenium, Tellurium, and Phosphorus and the Compounds. By Prof. Woldemar A. Weyl. Pp. iv+148. (Sheffield: Society of Glass Technology, 1944.) 10*s.* [55

The Development of Mathematical Logic and of Logical Positivism in Poland between the Two Wars. (Polish Science and Learning, Booklet No. 6, edited by the Association of Polish University Professors and Lecturers in Great Britain.) Pp. 48. (London: Oxford University Press, 1945.) 2*s.* 6*d.* net. [55

Ministry of Education. Pamphlet No. 1: The Nation's Schools; the Plan and Purpose. Pp. 32. (London: H.M. Stationery Office, 1945.) 6*d.* net. [125

Society of Chemical Industry. Reports on the Progress of Applied Chemistry. Vol. 28, 1943. Pp. 517. (London: Society of Chemical Industry, 1945.) [125

Falmouth Observatory. Report of the Committee, with Meteorological Notes and Tables for the year 1944. Pp. 12. (Falmouth: The Observatory, 1944.) [125

Other Countries

Thirty-second Annual Report of the Director to the Trustees of the Mellon Institute, covering Fiscal Year ended February 28th, 1945—The Third Year of War Research in Mellon Institute. By Dr. E. R. Weidlein. Pp. 29. (Pittsburgh: Mellon Institute of Industrial Research, 1945.) [284

Union of South Africa: Department for the Interior. Report of a Committee appointed by the Public Service Commission to inquire into a Medical Benefit Scheme for the Union Public Service. (In English and Africaans.) By Public Service Medical Benefit Scheme Committee of Enquiry. Pp. 46. (Pretoria: Government Printer, 1945.) [284

Bulletin of the American Museum of Natural History. Vol. 83, Article 6: A Preliminary Analysis of the Herpetofauna of Sonora. By Dr. Charles M. Bogart and Dr. James A. Oliver. Pp. 297–426. (New York: American Museum of Natural History, 1945.) [284

Air Department of New Zealand Meteorological Office. Professional Note No. 2: The Atmospheric Circulation of the Ross Area. By C. S. Ramage. Pp. 14. (Wellington: Meteorological Office, 1944.) [284

Transactions of the New York Academy of Sciences. Series 2, Vol. 7, No. 4: Electric Pulsations in Human Brain, by Dr. T. C. Barnes; Moral Values, by Dr. Charles Clark L. Hull; Interpretations of Andean Archeology, by Dr. Wendell C. Bennett. Pp. 87–106. (New York: New York Academy of Sciences, 1945.) [284

San Diego Society of Natural History. Occasional Paper No. 7: An Annotated List of the Marine Algae and Marine Grasses of San Diego County, California. By E. Yale Dawson. Pp. 85. (San Diego, Calif.: San Diego Society of Natural History, 1945.) [284