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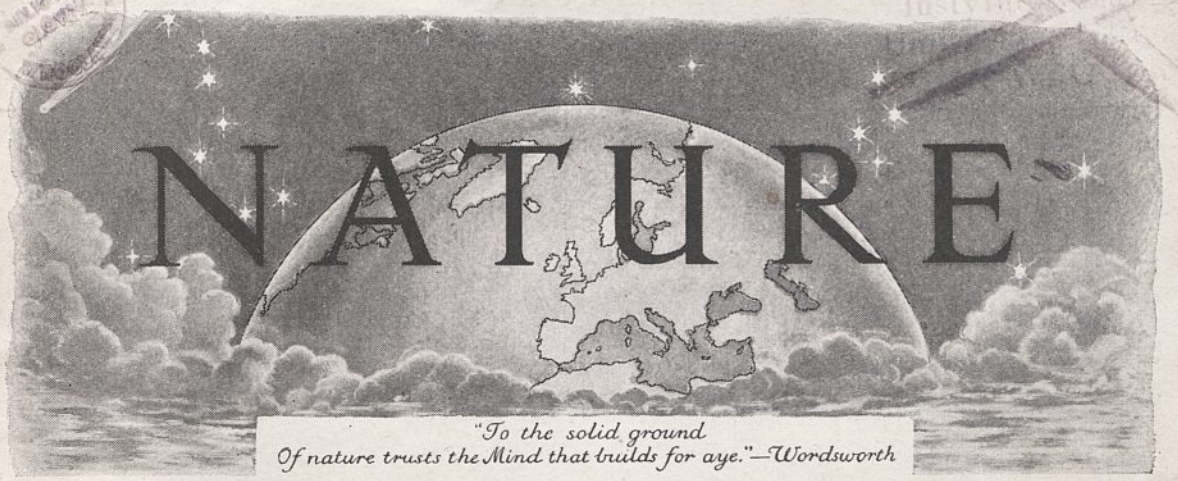

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NATURE

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THE RANKS OF LIBERTY

THE ranks of liberty have suddenly been thinned ; physically they are weaker, but the blow has made them spiritually stronger. The action of the present French Government at Bordeaux has without doubt resulted in the capitulation of the mother country of the French Empire ; what line of action will be followed by her Empire over-seas remains to be seen.

No one can lay a finger on a specific reason for this catastrophe ; though the causes leading up to it have been manifold. It would be useless to close our eyes to the fact that one of the major causes has been—science. As the Prime Minister pointed out in the House of Commons on June 18, if we fail, the world will sink into the abyss of a new Dark Age, "made more sinister and perhaps more prolonged by the lights of a perverted science".

When the history of the present time, and especially of the period leading up to it, comes to be written, blame will be, rightly or wrongly, apportioned. Men of science have often heard their calling castigated for the use to which it is put in making mass murder, torture, bad faith and even treachery so easy as it is to-day. So, when the time comes, men of science will receive their portion, probably in excess, of the blame usually meted out by superficial thinkers. As we pointed out in NATURE of June 15, p. 910 : "the conscience of science is clear. She offers man a rope to skip : she cannot be blamed if he chooses to hang himself with it." Thus are we glad to note that the Prime Minister realizes that it is a "perverted" science which is being utilized to further Totalitarian aims. We claimed that "science is willing, nay eager, to assist [man] along the path of prosperity and happiness which she has helped to provide." Alas, many of those in authority are still unable or reluctant to grasp the great importance of what science and scientific workers offer to the advancement of civilization.

Much has been said and written about the social relations and implications of science. Men of science were becoming more and more aware of the humanistic aspect of their work, and great efforts were being made to bring the blessings of science to the forefront. But little has been done to prevent the perversion of science. An all too clear object lesson is now before us ; and when the question of reconstruction can be usefully considered, this aspect must receive its due measure of attention—and a very large one it must be.

Meanwhile there is much to be done at once. Our thoughts turn to our French colleagues in their present sufferings. At the moment their fate is not known. Many of them are undoubtedly remaining at their posts. What the future holds for them remains to be seen ; if they are treated as the men of science of other occupied territories are being treated, they will be able to carry on their work in a modified form, regimented as regards hours, etc.—not an ideal atmosphere for scientific work.

It is quite possible that some French scientific workers have reached Great Britain, and others may perchance follow. These are early days, and one cannot foretell how many or what type of scientific worker may succeed in obtaining sanctuary in Great Britain. But whoever comes must be given not only sanctuary, but also an opportunity to pursue his calling. Those whose work is of immediate importance to the war effort should be absorbed into the various Government research departments ; the others, surely, will not

look in vain to our universities and other institutes of scientific research.

Over a period of several years, these centres of research have responded admirably to the call for aid from refugees from divers countries. Many such aliens have now been inevitably interned. Our French colleagues constitute a different category. Everything must be done to help them, though we fear that the terms imposed upon France will preclude most French men of science from leaving their country and continuing their work in that atmosphere of freedom which still prevails in Great Britain, and for which all British and all free French will continue to work and fight.

SCIENCE AND THE WAR EFFORT

SOON after the present Government took office, the Minister of Supply, Mr. Herbert Morrison, made a powerful appeal for intensification of effort in the production of munitions and other commodities, in the course of which he used a phrase, "Go to it", that has already become a slogan. He asked for speeding up of manufacturing processes, the over-riding of trade customs and the hard-won privileges of the trade unions, and in general the subordination of everyone and everything to the supreme task of winning the War. The military disaster in France has accentuated our need. From now on, Great Britain is the immediate target, and the need for munitions to replace losses in France, as well as to provide for the needs of the future, should require no emphasis.

The immediate demands of our war effort upon scientific workers and other technical experts are, of course, for the provision of the skilled work of control, in the testing of materials and products, and in the supervision of processes to ensure that the production of munitions of war, whether of explosives, guns, tanks, aeroplanes, war-chemicals or other products is smoothly, efficiently and safely maintained. This demands the continuous scrutiny of existing products and processes with the view of improving them and of replacing them by others superior to those used by the enemy.

All this, however, is only the first and possibly the least significant part of the contribution of science, great as are the demands it makes on the scientific worker for untiring accuracy, patience and skill. The nation's production of armaments must in some measure be related to the natural resources available. Unless the fullest possible use is made of these, we may be wasting our reserves of man power, of transport, or of foreign exchange.

It is difficult indeed to visualize the many ramifications here involved. The most effective utilization of coal, for example, affects not merely the manner of burning raw coal, its carbonization or conversion to coke or gas, or the generation of electric power. The by-product position has to be considered with reference to raw materials which it provides for explosives or other branches of chemical industry. Questions of atmospheric pollution and the like are also linked up with this question of efficient utilization of fuel, and it needs little imagination to visualize the reactions upon public health, problems of transport and the location of industry.

The importance of the scientific contribution is equally important in regard to questions of crop production. The decision as to which crops attention should be concentrated upon involves not merely an accurate knowledge of soil and climatic conditions, questions of shipping space, the interlocking of export policy and exchange reserves. It is linked up also with the whole policy of agriculture and food supply.

The importance of this latter question has been repeatedly stressed of late by Sir John Orr, Sir Daniel Hall, Mr. C. S. Orwin and others, who in the daily Press and elsewhere have stressed the necessity for a scientific policy of food production and directed attention anew to the valuable services rendered during the War of 1914–18 by the Food (War) Committee of the Royal Society. Their arguments have since been strongly endorsed in the Fourth Report of the Select Committee on National Expenditure, which expresses serious doubts as to whether sufficient use is being made of scientific research in regard to the wider issues in planning of food policy, such as the allocation of sugar or the planning on the basis of the fullest scientific study of a ration adequate in calories, etc., at a less cost in shipping and external currency than with the present normal form of diet. At present there is evidence that allocations of supplies are being made on the basis of a rough

and ready compromise between various interests, and not on the basis of a plan scientifically devised in the interest of the country as a whole.

The problems of scientific discovery and progressive industry must be of paramount importance in our war effort. Ultimately such problems, of course, resolve themselves into the effective utilization of natural resources—the adaptation of industrial processes and methods to provide the products required by a war-time economy, whether to meet the demands of the Fighting Services, essential civil needs or the requirements of the export market, from the raw materials available under war-time conditions. Equally urgent is the question of developing or expanding processes for products which previously have been imported in whole or in part from countries which are now cut off. Such development or expansion may involve in the first instance intensive scientific research; for example, in the field of medicinals it may be necessary to elaborate processes for products which are urgently required to meet immediate war needs. Other scientific work may be required for the production of scientific apparatus on a much larger scale, or for the supply of products such as dyestuffs to seize the opportunities in export trade which have been opened to us by the blockade.

In the main, such problems are already being tackled by industry. There must, however, be continuous improvement both of our products and processes in the light of new knowledge, whether for offensive or defensive purposes, the service of essential civil needs or the export market, to establish an overwhelming superiority over those used by the enemy. This is a matter which involves the most effective utilization of our whole structure for fundamental as well as industrial research, and the bringing into the service of our needs that creative intelligence which is one of our greatest assets, as it is one of the great values in the heritage which we are defending. Here, above all, scientific workers must make their main contribution, not merely in the skill and resource with which they grapple with the immediate problems confronting them, but also in visualizing new problems and in organizing the most effective mobilization of all the resources of scientific knowledge or personnel to serve our myriad needs in this desperate struggle.

Nor is this merely a matter for the application of scientific knowledge and methods on the production side of industry alone. Science has almost equally important contributions to make in perfecting our methods of civil defence, in the mitigation of strain imposed by such conditions as the black-out or evacuation measures, and in safeguarding the health of the industrial workers and indeed of the whole civil population.

If we are to secure the maximum output from our mechanical equipment, very careful attention must be given to such questions as hours of work, canteens, rest periods, and the organization of holidays, so as to avoid interruption of output or throwing a strain on transport. The report already issued by the Industrial Health Research Board on industrial health in war has emphasized the dangers to efficiency as well as to health which may result from excessive hours or continuous work without intervals for rest, and from failure to give adequate attention to such matters as lighting, ventilation or accident prevention, as indicated in the experience gained in this field in the War of 1914–18. A letter from the Association of Scientific Workers on p. 1024 of this issue refers to this question, and recent utterances of the Minister of Labour and the appointment of a Factory and Welfare Advisory Board shows that the difficulties are appreciated.

Other problems, too, call urgently for scientific management. Such methods offer the best way of securing the more rational distribution of orders, increasing the mobility of labour and operating an efficient system of priority. Equally they play an important part in training the new workers required by industry for war purposes and in discovering, for example, just what kinds of skill can be acquired by intensive methods of only a few weeks duration. Technical education demands attention, for the training of highly skilled and responsible men in industry is a long-period problem, which must not be overlooked although the main and immediate problem of training is concerned with the hundreds of thousands of machine operators who are already needed.

If the tremendous drive in our industrial war effort to which we have been summoned by the Minister of Supply is to reach its full effect, it must be based on scientific knowledge and guided by scientific methods at all stages, in the planning of policy, in the development and in the control of processes and products. The contribution of scientific workers will demand the utmost vigour of creative thought and fundamental research, no less than the intense prosecution of the team-work characteristic of industrial research.

SALVAGE AND UTILIZATION OF WASTE

IT is of the very essence of war that every resource must be used to resist the advance of the aggressor. There is no room for half-measures; the War is the concern of every one of us; a steadfast purpose, high resolves and a capacity to put those resolves into action should dwell in the hearts and minds of all.

"What can I do to further the ends for which our country is struggling, to keep alight the lamps of freedom of thought and speech?" is the question on the lips of millions of our fellows. "The work of the armed forces is clear before them; the farmer is providing essential food; the munition-workers' contribution is of primary importance. But what can I give to the cause, save by paying taxes, and by carrying on with my own work?"

Much; and in many directions. An essential and vitally important help which every one of us may give, is summed up in the one word *economy*. Economy will indeed be forced upon us, for when the British national income at the outbreak of war was reckoned at £6,000 million per annum, the Government was taking from this income about £1,200 million. Thus £4,800 million were left in the pockets of the people. But if, owing to increased War-time effort, the national income should rise to £7,000 million, and the annual national expenditure to £4,000 million, then expenditure by the public *must* fall to £3,000 million. There is no gainsaying this. Economize we must, and it is well to begin early.

This, however, is but the passive side of war economy. Waste has a wide meaning, and while it is incumbent on each one of us to practise economy and to avoid waste, we must recognize the fact that there is an active side to the problem and another meaning to the term *waste*. Waste products of one trade are valuable raw materials for another; waste household products which in peace-time were rightly consigned to the flames, the rubbish heap, or the attic, become, in these days of war, essential parts of the national economy. Their usefulness must not be judged by ordinary economic standards; the national need is the determining factor. So important and pressing is this matter, that a special department of the Ministry of Supply—the Salvage Department—has been set up, which makes the gathering and utilization of such products its special concern.

The figures which deal with the amount of preventable waste are impressive. Thus, before the War, twenty thousand tons of paper and cardboard were thrown weekly into Great Britain's dustbins—well over a million tons a year. Such waste in war-time is almost criminal, and the Salvage Department is to be congratulated on the successful steps which it is taking to diminish this waste. During November last, the tonnage of waste paper collected was 4,500; during April of this year, 9,000.

There are few things considered less useful than woollen rags. Nevertheless, such rags are used in the manufacture of high-grade paper, and are the raw material of an industry that has flourished in the West Riding of Yorkshire for more than a century. This industry depended in the past on large supplies imported from abroad, and here, as in the paper industry, a substantial increase in the home supply will proportionately reduce the strain on shipping. They who produce, from the recesses of their wardrobes, old and long-discarded clothes, and see that they reach the appropriate distributing agency, will be doing a very real and important service. So also with ferrous (and non-ferrous) metals, all of which take on a new value as potential sources of high-grade steel.

The utilization of animal and vegetable refuse presents most curious and varied technical problems. Some of these problems have been efficiently solved; many others await solution. Most unexpected uses are to be found for various types of such refuse. Banana stalks, for example, of which many tons are available, are a most useful source of fertilizing material, and the household cooked bone has, from this point of view, scarcely any waste. One-eighth of its weight content is fat, one-eighth glue, and the remaining three quarters, properly treated, will appear as feeding meal for cattle, or as bone-fertilizer.

Here, then, is an example of work in which every one of us, townsman or countryman, child or adult, can take part. Such help as a single individual can give may seem a small matter, but in the aggregate the results obtained may be of far-reaching importance. The Salvage Department is doing its work well. In five months the number of town and other councils making returns has risen from 320 to 900, the populations which these

councils represent being, in the first instance, 23 millions; in the second, 38 millions. This is a remarkable increase; but it must not be taken to imply that all the councils and local authorities in Great Britain are working at full pressure, or that they have completely developed their methods of attack on the task of the utilization of waste. Different councils have to face different aspects of the problem, and their solution calls for active co-operation between chemist, physicist, biologist and engineer. But the problem of bringing together the waste material is one to which everyone can lend a hand, and the schools can play a specially important part in this task.

Hitherto, the salvaging of waste material has been voluntary, in that local authorities have been asked to provide for the separate collection of material which can be utilized. The Minister of Supply has now announced that all local authorities with populations of more than 10,000 will be required to arrange efficient systems for the collection of salvage, and householders in these areas will be obliged to co-operate. Waste paper and cardboard, scrap metals and household bones are urgent needs, and other materials such as waste food and rags may be added to the list at a later date. The fact that a measure of compulsion is to be introduced need not deter the individual from continuing his own effort, on which, in the long run, will depend the outcome of the official drive for the collection of utilizable waste material.

A PIONEER IN PSYCHOLOGY

Psychological Issues
Selected Papers of Prof. Robert S. Woodworth. With a Bibliography of his Writings. Pp. x+421. (New York: Columbia University Press; London: Oxford University Press, 1939.) 22*s.* net.

WILLIAM JAMES once declared that psychology was not a science, but only the hope of a science. Much water has flowed under the bridges since that statement was made, and psychology may fairly be said to have proved its claim to recognition, notwithstanding that it is still split up into warring schools or sects. Few men have done so much to bring about the change as R. S. Woodworth, professor of psychology at Columbia University. As a student under James at Harvard, and later on as an assistant to Cattell at Columbia, he came under two powerful influences, which helped to shape his career, and partly explain the breadth of his interest in psychological problems, both on the physiological and on the statistical side. He has recently passed his seventieth birthday, and his colleagues in the department of psychology at Columbia, where he has taught for thirty-six years, have, without his knowledge or consent, prepared this commemorative volume. It was a gracious act, and one which will be warmly approved by many who only know Prof. Woodworth by his writings.

Most students of psychology know him by his "Psychology", a standard work now in its third edition, and by his "Contemporary Schools of Psychology" (1931), a book which bears the clear impress, not only of its author's ripe learning, but also of his wisdom and his sanity of judgment. Most of Prof. Woodworth's original work, however, consists of contributions to scientific journals spread over a period of more than forty years, with a list of titles covering a dozen octavo pages. This volume comprises some of his most distinctive work, ranging from an early note on the alleged rapidity of dreams (1897) to a paper for the *American Journal of Psychology* in 1937.

Not the least interesting part of the book is the chapter of autobiography written in 1932 for a comprehensive volume recording the careers of distinguished living psychologists. To an English reader there is one rather odd statement in this chapter. Prof. Woodworth relates that when he began studying psychology in September 1890, James's "Principles" had not yet appeared, and that there was probably no book in existence, at any rate in English, which could be recognized to-day as a text-book in psychology, the nearest approach being Carpenter's "Mental Physiology", a book dating from about 1870. This is surely rather hard on Prof. James Sully, a true man of science, whose "Outlines of Psychology", published in 1884, had completely superseded such books as Carpenter's and Bain's by the time that young Woodworth set out upon what proved to be a career of distinction. Perhaps it has made no difference in the end (who can tell?); but it must have made a difference at the beginning, that his advisers were not up to date.

CRYSTALLINE ENZYMES

Crystalline Enzymes

The Chemistry of Pepsin, Trypsin and Bacteriophage. (Columbia Biological Series, No. 12.) By John H. Northrop. Pp. xv + 176. (New York: Columbia University Press; London: Oxford University Press, 1939.) 15*s*. net.

THE chemical nature of enzymes has in the past been the subject of acute controversy. It has seemed impossible to many investigators to associate with molecules of high molecular weight their extraordinary power of controlling the complex reaction of living systems. Yet it is becoming more and more difficult to separate the study of enzyme activity from that of the proteins with which it is associated, and this is particularly true when we deal with crystalline enzymes. The characteristic activity of enzymes provides the most delicate test for their presence; they may be detected in solutions much too dilute to give positive protein reactions. But the enzyme crystals so far obtained are all protein crystals, and their preparation has proved an important step in relating the chemistry of enzymes to that of proteins as a whole. Since Sumner's first isolation of crystalline urease in 1926, some twelve different enzymes have been obtained in crystalline forms the variety of which reflects their diverse and specific chemical character. Of these, one of the most remarkable groups is that of the proteolytic enzymes studied by Northrop and his collaborators.

Northrop's present monograph is essentially an authoritative account of his own researches and does not deal, except in a general introductory way, with crystalline enzymes as such. It does include a general account of the problem of enzyme catalysis and reaction kinetics, but the sub-title of the book provides a more accurate description of its scope. For the principal beauty of Northrop's work lies not so much in the investigation of a large number of different enzymes as in the isolation of several closely related proteins and the study of their reactions one with another. We have here the beginnings of a chemistry of pepsin and trypsin in the same sense that we might speak of the chemistry of aniline—including the preparation of crystalline derivatives and the conversion of one protein into another and related and crystalline protein. But this chemistry of molecules of weight 30,000–40,000 is on a different scale of magnitude altogether from that we are accustomed to meet in classical organic chemistry.

Pepsin itself crystallizes in very characteristic hexagonal bipyramids which may, like many other protein crystals, contain a large proportion of impurities. The separation of different protein constituents during purification is best followed by solubility measurements, which distinguish pepsins derived from different sources, for example, swine and chicken pepsin, when other tests fail. So far it has proved impossible to relate the activity of pepsin to a particular prosthetic group, though it is evidently dependent on the presence of tyrosine in the molecule. One of the several reactions supporting this is acetylation, which leads under different conditions to the production of three different acetyl pepsins, all of them practically identical in crystalline form with pepsin itself. Only as the tyrosine groups are attacked in the second and third of these does the activity fall, first to 60 per cent, then to 10–15 per cent of its original value. A more profound modification of the molecule is involved in the formation of pepsin from its inactive precursor pepsinogen, which can be obtained crystalline in fine needles. Unlike pepsin, pepsinogen is stable in alkaline solution and is converted into pepsin by an autocatalytic reaction in acid solution. This reaction probably involves some splitting of the protein molecule; the two proteins are actually very similar in composition apart from the rather higher amino nitrogen content of pepsinogen.

A second important group of enzymes are the proteolytic enzymes of pancreatic juice, trypsin, chymotrypsin and carboxy peptidase. Trypsin and chymotrypsin both form particularly complicated series. Both have precursors, chymotrypsinogen (long needles) and trypsinogen (small triangular plates), which are converted into the active compounds under the influence of enterokinase, trypsin, and in the case of trypsinogen, a mould kinase. Chymotrypsin itself crystallizes in rhombohedra, but from its solutions separate two other enzymes, β-chymotrypsin (plates) and γ-chymotrypsin (short prisms). These are probably produced by slight hydrolysis of chymotrypsin itself, as they have lower molecular weights. Although similar in activity, they are distinct proteins with different solubilities which form solid solutions below *p*H 5·0 but crystallize independently between *p*H 5·0 and *p*H 6·0. The formation of trypsin from trypsinogen is complicated by the presence of a most interesting compound, trypsin inhibitor, which appears to be a polypeptide of molecular weight about 6,000. This crystallizes in long hexagonal prisms and with trypsin forms a 1 : 1 compound, also crystalline, inhibitor trypsin compound.

Among the most remarkable reactions described is that of reversible "denaturation", which is shown particularly by pepsinogen, chymotrypsin and trypsin. Solutions of these proteins may be heated to boiling and cooled again without loss of activity or potential activity. If the hot solutions are tested it is found that the protein present is inactive and can be precipitated by the addition of salt as if it were denatured. In the case of pepsinogen the protein is completely native below 50°, completely changed above 70°, and yet activity is restored on cooling. It would perhaps be better to use some special term instead of denaturation for this change, such as degeneration, as Astbury has suggested, since on long heating further changes take place which prove to be irreversible.

The study of the bacteriophage is still a stage outside the scope of the title of the book. It behaves in many ways as a nucleoprotein and its activity is destroyed by chymotrypsin, though not by pepsin or trypsin. Also heat-inactivated phage may be reactivated under certain conditions. But no phage has yet been crystallized, and Northrop concludes that it is impossible on the data obtained up to the present to decide whether phage should be classified with enzymes or with cells.

Northrop's monograph is throughout largely an account of work in progress and indeed of work which it is to be hoped will progress a great deal further. It is chiefly designed for the research worker in the field, who should find the detailed tables of preparations included in the appendixes invaluable. But the subject itself is of such interest and its presentation so clear that the book should have a very much wider appeal.

In conclusion, it would be worth buying if only for the very beautiful photographs of enzyme crystals that it contains.

DOROTHY CROWFOOT.

VIBRATION IN ENGINEERING PRACTICE

Mechanics Applied to Vibrations and Balancing

By D. Laugharne Thornton. Pp. xii+529. (London: Chapman and Hall, Ltd., 1939.) 36*s*. net.

ALTHOUGH there is no dearth of recent books on the subject of vibrations and the methods of balancing them, they all assume on the part of the reader a considerable knowledge of, and familiarity with, the dynamical principles on which the whole reasoning and mathematical treatment are built up. This, of course, is an essential preliminary but, owing to the different modes of presentation adopted by individual authors, there is for the average reader a somewhat difficult transition to be effected in switching from one form to another. For the designer, too, who has not been closely engaged in the more difficult problems of balancing, the first requisite is that these fundamentals should be clearly re-stated in direct association with the development of the main argument.

In this book, the author has dealt with each phase from the simplest beginnings, and has made a clear exposition of the basic principles the starting point of each argument. Although writing primarily for engineers and dealing with his subject in terms of units appropriate to the requirements of practical design, he has at the same time been sufficiently analytical to give his work a definite value to the student of physics, for whom an unusually wide range of examples is provided. On the mathematical side, a good working knowledge of the elements of calculus and of analytical geometry is a sufficient pre-requisite, as, where additional mathematical equipment is required, suitable explanation is given.

In the arrangement of the work two objects are clearly recognizable, the first being that of demonstrating the relation between the vibrations of unbalanced machinery and the vibratory motions thereby set up in foundations and supporting structures. These vibrations and their effects are particularly exemplified in chapters dealing with the influence of aero-engines on their fuselages and those of stationary, locomotive and marine engines on their surroundings. In dealing with the unbalanced dynamical forces and couples associated with these and other types of machines, Lagrange's equations are employed, and are enunciated and explained in some detail because of their utility in this connexion and also because of their value as an introduction to the idea of generalized co-ordinates as used in the more advanced theory of vibrations. Lagrange's method has the advantage in this type of analysis of enabling the main parts of an engine to be considered successively, so that it is possible to trace the relative motion between two parts due to the effect of a change of load and the elasticity of the connecting materials.

The second aim which can be noted is the presentation of problems pertaining to the design

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A second important group of enzymes are the proteolytic enzymes of pancreatic juice, trypsin, chymotrypsin and carboxy peptidase. Trypsin and chymotrypsin both form particularly complicated series. Both have precursors, chymotrypsinogen (long needles) and trypsinogen (small triangular plates), which are converted into the active compounds under the influence of enterokinase, trypsin, and in the case of trypsinogen, a mould kinase. Chymotrypsin itself crystallizes in rhombohedra, but from its solutions separate two other enzymes, β-chymotrypsin (plates) and γ-chymotrypsin (short prisms). These are probably produced by slight hydrolysis of chymotrypsin itself, as they have lower molecular weights. Although similar in activity, they are distinct proteins with different solubilities which form solid solutions below *p*H 5·0 but crystallize independently between *p*H 5·0 and *p*H 6·0. The formation of trypsin from trypsinogen is complicated by the presence of a most interesting compound, trypsin inhibitor, which appears to be a polypeptide of molecular weight about 6,000. This crystallizes in long hexagonal prisms and with trypsin forms a 1 : 1 compound, also crystalline, inhibitor trypsin compound.

Among the most remarkable reactions described is that of reversible "denaturation", which is shown particularly by pepsinogen, chymotrypsin and trypsin. Solutions of these proteins may be heated to boiling and cooled again without loss of activity or potential activity. If the hot solutions are tested it is found that the protein present is inactive and can be precipitated by the addition of salt as if it were denatured. In the case of pepsinogen the protein is completely native below 50°, completely changed above 70°, and yet activity is restored on cooling. It would perhaps be better to use some special term instead of denaturation for this change, such as degeneration, as Astbury has suggested, since on long heating further changes take place which prove to be irreversible.

The study of the bacteriophage is still a stage outside the scope of the title of the book. It behaves in many ways as a nucleoprotein and its activity is destroyed by chymotrypsin, though not by pepsin or trypsin. Also heat-inactivated phage may be reactivated under certain conditions. But no phage has yet been crystallized, and Northrop concludes that it is impossible on the data obtained up to the present to decide whether phage should be classified with enzymes or with cells.

Northrop's monograph is throughout largely an account of work in progress and indeed of work which it is to be hoped will progress a great deal further. It is chiefly designed for the research worker in the field, who should find the detailed tables of preparations included in the appendixes invaluable. But the subject itself is of such interest and its presentation so clear that the book should have a very much wider appeal.

In conclusion, it would be worth buying if only for the very beautiful photographs of enzyme crystals that it contains.

DOROTHY CROWFOOT.

VIBRATION IN ENGINEERING PRACTICE

Mechanics Applied to Vibrations and Balancing

By D. Laugharne Thornton. Pp. xii+529. (London: Chapman and Hall, Ltd., 1939.) 36*s*. net.

ALTHOUGH there is no dearth of recent books on the subject of vibrations and the methods of balancing them, they all assume on the part of the reader a considerable knowledge of, and familiarity with, the dynamical principles on which the whole reasoning and mathematical treatment are built up. This, of course, is an essential preliminary but, owing to the different modes of presentation adopted by individual authors, there is for the average reader a somewhat difficult transition to be effected in switching from one form to another. For the designer, too, who has not been closely engaged in the more difficult problems of balancing, the first requisite is that these fundamentals should be clearly re-stated in direct association with the development of the main argument.

In this book, the author has dealt with each phase from the simplest beginnings, and has made a clear exposition of the basic principles the starting point of each argument. Although writing primarily for engineers and dealing with his subject in terms of units appropriate to the requirements of practical design, he has at the same time been sufficiently analytical to give his work a definite value to the student of physics, for whom an unusually wide range of examples is provided. On the mathematical side, a good working knowledge of the elements of calculus and of analytical geometry is a sufficient pre-requisite, as, where additional mathematical equipment is required, suitable explanation is given.

In the arrangement of the work two objects are clearly recognizable, the first being that of demonstrating the relation between the vibrations of unbalanced machinery and the vibratory motions thereby set up in foundations and supporting structures. These vibrations and their effects are particularly exemplified in chapters dealing with the influence of aero-engines on their fuselages and those of stationary, locomotive and marine engines on their surroundings. In dealing with the unbalanced dynamical forces and couples associated with these and other types of machines, Lagrange's equations are employed, and are enunciated and explained in some detail because of their utility in this connexion and also because of their value as an introduction to the idea of generalized co-ordinates as used in the more advanced theory of vibrations. Lagrange's method has the advantage in this type of analysis of enabling the main parts of an engine to be considered successively, so that it is possible to trace the relative motion between two parts due to the effect of a change of load and the elasticity of the connecting materials.

The second aim which can be noted is the presentation of problems pertaining to the design

of buildings to withstand earthquakes, of which the author has had unique experience. This subject is discussed and illustrated by solutions to problems in which prescribed buildings are considered as a whole and as a structure composed of interconnected beams, columns and trusses. Here, too, the important question of foundations is dealt with, and in the same group may be mentioned the vibratory effects of traffic on roads.

The range of examples introduced is much too wide to be particularly classified, but it may be mentioned that they are representative of civil, mechanical, aeronautical, structural and marine engineering, and afford trustworthy guidance for most cases met with in practice.

ROCK-PAINTINGS IN SOUTH AFRICA

More Rock-Paintings in South Africa

From the Coastal Belt between Albany and Piquetberg. Mainly copied by Joyce and Mollie van der Riet. With Notes by the same and an Introduction and Explanatory Remarks by Dorothea F. Bleek. Pp. xx+28+28 plates. (London : Methuen and Co., Ltd., 1940.) 42*s*. net.

THIS volume, which has only thirteen pages of text, one map and twenty-eight plates with an explanatory page by Miss Bleek for each sheet of plates, describes a chosen number of rock paintings in the district of Grahamstown, halfway between Cape Town and Durban. They are some of the 145 examples copied by Miss van der Riet, Mrs. Ginn, Miss Sheila Fort and Miss Bright. There are also three plates of rather mediocre rock engravings, interesting because they show the extension southwards of this type of art. Some photographs of the originals are included.

On the whole, the art of the panels reproduced is not of a very high level, although the elephant shaded in reddish-brown (pl. 16–17) is very fine and so are the clothed and equipped archers (pl. 26), recalling some of the finest panels of Natal.

Among the most interesting subjects reproduced, all purely Bushman and previous to the arrival of other races, are the line of galloping springboks (pls. 15, 17, 19, 21*A*) in red, in the style I call 'spidery' ; the battle between two tribes of Bushmen (pl. 5*A*) in red ; the group of kneeling archers also in red drawing their bows (pl. 6*B*) ; the flying birds and circles of seated men painted in red (pl. 23) ; the little elephants grouped in a footprint of that animal (?) (pl. 27) also in red.

We must mention certain animals with their outline drawn in red and not filled in with colour, such as those in pl. 8*A* and *B* : one of these is an antelope, not an ox, with its horn (pl. 8*A*), seen full face, an example of twisted perspective rare in South African art.

There are very few big two-colour paintings of elands, and they are poor (pls. 1 and 28) ; the better two-colour paintings, which are rather good, are of antelopes (pl. 5*B*) and quagga (?) (pl. 10*B*). There are a few plants (?) (pls. 14*A* and 24) ; a rainbow (?) (pl. 7) ; an apron (?) (pl. 7) ; a skin water bottle (?) with its cords (pl. 19) near a man who seems to be climbing skywards with a rope ; the spots near him suggest a rain-making rite.

A good many superpositions of the paintings are mentioned, only some of which are shown (pl. 5 *A* and *B*) ; brownish-red on faded red (pl. 23) ; three levels, yellow, red, then black (pl. 26) ; the black figures are obviously the latest in pls. 7, 9, 20, 25, 26 ; there are several paintings of baboons. A fine white and black ostrich reminds us of the celebrated ones published by Stow with the hunter disguised as an ostrich (pl. 2).

It is a pity this volume does not contain the whole block of paintings copied, even if only as small line drawings, for the chief interest in a regional investigation lies in an exhaustive study of the superpositions and styles which it exhibits. For example, stencilled feet and hands are mentioned, but there is no reproduction of them. It is said they are sometimes older and sometimes more recent than the figures ; I can only say that at Riversdale, as at Wilton, where I saw them, they were far older than the figures. No late panels are given showing sheep, oxen, horses, etc. ; such plates would have been valuable, making the book more complete. I have seen, for example, at Wilton, a big group of Hottentot white sheep with fat tails.

Still we thank Miss Bleek for having, so far as she could, enriched this publication, which completes her previous magnificent volume, and encourage her to pursue her fascinating study. She has pointed out in the text, with that authority which is her right, the differences in the artistic character of the various South African regions, differences which I need not enumerate.

H. BREUIL.

EARLY BOTANY AT OXFORD*

By Dr. J. Ramsbottom, O.B.E.,
British Museum (Natural History)

JOHN JACOB DILLENIUS was born at Darmstadt, Germany, in 1684. He studied at the University of Giessen, like several of his family before him. At an early age he became a member of the Academia Naturæ Curiosorum and contributed several papers to the *Miscellanea Curiosa* of that Society from the year 1715 onwards: among other matters these dealt with American species of plants which had become naturalized in Europe; Arabian coffee and his own *ersatz* preparations made by roasting peas, beans, kidney-beans and rye, the last being barely distinguishable from the real thing; the examination of mosses and other cryptogams with the view of ascertaining their sexual organs; and an experiment made with opium he had prepared from *Papaver somniferum* grown in Europe. He also wrote on leeches and butterflies.

In 1719 he published his "Catalogus plantarum sponte circa Gissam nascentium", a work which immediately established his reputation. It contains a list of plants gathered within a circuit of about a German mile and a half—approximately 980 species of flowering plants, 200 species of Musci and 160 species of Fungi; a large proportion of the Cryptogams had not previously been described. There is a critical examination of the systems of Ray, Knaut, Rivinus and Tournefort. Dillenius himself followed Ray's system throughout his career.

It was as a direct result of the catalogue that Dillenius was invited to Great Britain. William Sherard was at that time eminent in botany, so much so that Dawson Turner called him "the Sir Joseph Banks of his time". He had studied under Tournefort at Paris and later in 1704 was appointed Consul at Smyrna and there made a collection of plants and also did antiquarian exploration. At Tournefort's suggestion he undertook the continuation of Casper Bauhin's "Pinax", and on his return to England in 1716 he devoted himself to completing the work. The neglect of Cryptogams in Great Britain led him to enter into correspondence with Dillenius in 1718, and three years later, after sending for him, brought him over. Dillenius was engaged upon naming Sherard's collection of Smyrna plants and also on the "Pinax".

*From the presidential address delivered before the Linnean Society of London on May 24, which dealt with a collection of drawings recently acquired by the Department of Botany, British Museum.

By that time the second edition of Ray's "Synopsis Methodica Stirpium Britannicarum", published in 1696, had become scarce, and Dillenius was employed in helping to prepare a new edition. This was published on July 17, 1724.

In 1726 Dillenius made a tour of the west of England and Wales in company with Samuel Brewer; Littleton Brown made part of the journey.

William Sherard died in August 1728 and left his books and plants and £3,000 for the maintenance of a professor of botany at Oxford. He nominated Dillenius to be the first professor for life.

Dillenius was fully satisfied with his work on the "Pinax", but James Sherard, after his brother's death, persuaded him to write an account of the plants cultivated in his garden at Eltham. "Hortus Elthamensis" appeared in 1732 in two folio volumes of 437 pages and 324 plates drawn and engraved by Dillenius. A large number of the then known species of Mesembryanthemum are figured and also some rare British plants. Sprengel described it as a most splendid work and Linnæus as "a botanical work such as the world had not seen". But Dillenius grudged the time he had spent on it. Further, he was shabbily treated by James Sherard, who complained that "he has not studied either to adorn his book or my garden; his chief care having been to improve and advance the Knowledge of Botany"—and Dillenius had to bear the cost of the production of a work James Sherard had designed "to make himself known". Many of the type specimens are preserved at Oxford. The drawings appear to have been lost.

There was difficulty over the Oxford appointment because of James Sherard's executors going to law, and Dillenius did not take up residence in Oxford until 1734, six years after William Sherard's bequest. In 1741 he published his "Historia Muscorum", a quarto volume of 576 pages and 85 plates—mosses including Bryophytes, Hepatics, Lycopods, Algæ and lichens. The original drawings of the figures on the first seventy-nine plates are in the Department of Botany; the remaining six plates were apparently drawn and etched directly on the copper. Dillenius died in April 1747 at the age of sixty-three—the great "Pinax" unfinished.

Such in outline is the life of one of the foremost systematists of his time—Linnæus says of the genus Dillenia, "of all plants the most distinguished for the beauty of its flower and fruit, like Dillenius among botanists".

Although Dillenius gained a considerable reputation from his Giessen Catalogue, this was chiefly because of the prominence he gave to Cryptogams. His Musci include not only the true mosses but also the lichens and some Algæ. For the first time mosses were split up into genera and names such as Mnion, Hypnum, Polytrichum, Bryum, and Sphagnum he took from Theophrastus, Dioscorides and Pliny.

Three years before the appearance of the Catalogue, Marsigli and Lancisi had published their letters on the nature of Fungi. Dillenius adopted their ideas, and his opinion is often quoted in the discussions which went on for a century or so. "A fungus," he says, "is a sterile kind of plant, that is to say destitute of flower and seed, arising from putrefactive fermentation, wherefore they arise chiefly during a moist and rainy period and consist for the most part of a soft and spongy substance yet retaining its characteristic look which it owes to a definite and specific juice of decay from which it originated ; and so, since by this putrefactive process the texture and elements of vegetables are considerably altered and almost destroyed, Fungi do not possess a green colour or have leaves, or even texture like other plants. Another consequence is that they usually spring up in a short space of time and are of equally short duration, or become the habitat and food of grubs and beetles, with the exception of not a few arboreal species that spring from the less liquid juices of wood and therefore last longer."

In spite of this belief which, logically, means that Fungi have no separate entity, Dillenius paid considerable attention to them and describes 162 species in his Catalogue. Drawings of 114 of these are in the present collection with 52 additional drawings. They are painted on separate pieces of paper and stuck on sheets on which the details are given. These drawings serve as the types of Dillenius's species and give his interpretations of previous descriptions.

Dillenius was recommended to Sherard "as a person very curious in mushrooms and mosses, as I perceive he is," and later Sherard writes : "I have brought over with me Dr. Dillenius who has with him most (if not all) of his *Fungi* painted". These drawings must be the ones mentioned. They are not of high artistic merit.

There is also a set of wash drawings of Fungi, all mounted on the same size of paper and arranged as if for publication. They seem to be copies, but they are from no work I know and, so far, I have not been able to match a single one of them except in Dillenius's own drawings. Can it be that they are the drawings mentioned by Sherard in a letter to Richardson dated December 26, 1723 ? "Dr. Dillenius has much improv'd in his painting. He has copied for me all Mr. Dandridge's *Fungi* and as many as he has been able to procure about London". Or are these, as Dr. Druce suggested, included in the drawings of Fungi at Oxford. These latter number 264 : the printed matter in Druce's "The Dillenian Herbaria" does not appear to support the suggestion for Dandridge's name is scarcely mentioned ; some of the Fungi are said to be from Giessen.

Another set of drawings, also in wash, is entitled "Plantæ novæ aut rariores ex Ephem. Nat. Curiosorum". It will be remembered that Dillenius himself was a member of the Academia Naturæ Curiosorum. These drawings on sixty-four sheets are copied from various plates which appeared in the Ephemerides together with full notes, and from Mentzel's "Pugillus" and Alpinus and Vesling's "De Plantis Aegypti". These, I imagine, date from his Giessen days, indeed probably when he was a student.

Although Dillenius's name is not on the third edition of Ray's "Synopsis" it would have been possible to guess that he was the editor even if it were not known for certain otherwise, for the classification adopted is practically that of the Giessen catalogue. It is common knowledge, however, that his name was omitted as "there was some apprehension (me being a foreigner) of making natives uneasy, if I should publicate it in my name". He had wished to dedicate it to Sherard and R. Richardson, "two persons that have contributed the most to its perfection", but the dedication being anonymous was "to all those Lovers of Botany, who contributed the most to the edition". There was even a suggestion that Isaac Rand's name should be given as editor, which apparently Sherard approved of, though he had himself done far more work on the "Synopsis", having on occasion worked ten hours a day on it. The "Synopsis" was illustrated with twenty-four plates. The only reference I have found to the fact that Dillenius did these is in a letter from Sherard to Richardson in which he says : "I know nothing further Dr. Dillenius has to do to the *Synopsis*, but the getting grav'd a few more plates, which may be done whilst 'tis printing". Richardson sent the money to pay for two plates, but Sherard returned it saying that it was a proper charge upon the publisher. The present collection contains the original drawings of all the plates except plate 1, though a few of the figures are missing ; the drawing for plate 23 is in pencil in an unfinished state. The original figures of plate 1,

which illustrate Fungi, are amongst the Oxford drawings, according to Druce. Most of the drawings have the red chalk used in engraving still showing on the reverse side. But the interesting fact is that apparently it was intended that there should be sixty-eight plates. I have not traced any reason why all were not published.

The collection also includes a number of British plants. The specimens are in the Dillenian Herbarium at Oxford. There are further fifty sheets of drawings of plants probably from Giessen, and also sixty-three drawings of rushes, sedges and grasses.

The most numerous drawings are a set of about 320 labelled "Designationes and Icones plantarum in Horto Oxoniensi crescentium . . . 1744, 1746 dipictae." They are of great artistic merit and it need not be stressed that they are botanical drawings. In my opinion they place Dillenius among the front rank of botanical artists; it scarcely seems possible that they are by the same hand as some of the earlier drawings.

The Oxford Botanic Garden dates from 1621 and had only been planted with "divers simples for the advancement of the faculty of medicine" when the Civil War broke out. Jacob Bobart the elder was the first gardener appointed, though it seems that Lord Danby, founder of the garden, had previously negotiated with John Tradescant. The definite agreement between Lord Danby and Bobart was drawn up in 1641. Under Bobart's care the garden acquired a great reputation, and a catalogue of the plants there cultivated was published in 1648; 1,600 plants are included of which 600 were British. A second edition appeared ten years later with Philip Stephens and William Brown as co-editors with Bobart. Jacob Bobart the younger succeeded his father as keeper of the Physic Garden in 1679. There are two manuscript catalogues of plants growing in the garden and its neighbourhood in the Botanical Library at Oxford, and a number of manuscript lists of seeds and plants mostly sent or received by Bobart, in the Sloane Library.

After Bobart's retirement in 1718 there was no activity until the appointment of Dillenius. Sherard and others sent plants and seeds, but the neglect which had begun as Bobart grew old and feeble continued until 1734. Linnæus's famous visit to Oxford took place in 1736. It is probable that his main object was to see Sherard's herbarium, which in his judgement excelled all others in European plants, but the opportunity of meeting Dillenius was doubtless an additional attraction. There are several accounts of this visit. Dillenius, writing to Richardson, said that the visit lasted eight days, whereas Linnæus says that the learned Dillenius was at first haughty and distant, conceiving the "Genera Plantarum" to be written against him; but that he afterwards detained him for a month, without leaving him an hour to himself the whole day long, and at last took leave of him with tears in his eyes, after giving him the choice of living with him until his death, as the salary he thought was sufficient for them both.

By collating these various lists with the present drawings it should be possible to gain some idea of the plants in cultivation at Oxford when Dillenius was professor.

What was the purpose Dillenius had in mind in preparing these drawings? They were done with such care that it scarcely seems credible that they were drawn merely for amusement. We know that Dillenius regretted every moment away from the "Pinax" and yet here we have an enormous amount of time spent with what seems to be no purpose. Was it that Dillenius had in view the preparation of a volume dealing with the Oxford garden similar to "Hortus Elthamensis"? He certainly would have found it more congenial to work as he pleased than under the selfish criticism of James Sherard.

Dr. Druce overlooked the fact that Dillenius was a correspondent of John Bartram. His letters were usually sent through Peter Collinson, who also distributed seeds collected by Bartram. In 1737 Collinson sends names of his plants from Dillenius, and Dillenius received collections of seeds and plants until 1742. Bartram also collected mosses. "Before Dr. Dillenius gave me a hint of it, I took no particular notice of Mosses, but looked upon them as a cow looks at a pair of new barn doors."

We know that Dillenius was thoroughly dissatisfied at the loss he encountered by having to finance the publication of "Hortus Elthamensis". At James Sherard's desire he printed off 500 copies, but decided to have only 145 copies of the plates. Half a hundredweight of the paper—best Dutch paper—he sent to Bartram through Collinson, who wrote that it would "make noble books for specimens" and "think will furnish thee with paper for specimens, and for seeds, for thy lifetime". Drawings of some of the plants grown from Bartram's seeds are in the collection.

The last of the Dillenian material about which I wish to speak is the manuscript "Classis of Water Plants". It consists of thirty-two pages evidently written while in England and probably before he went to Oxford. He divides the plants into two groups: (1) such as bear neither (conspicuous) flowers, nor seeds, but propagate themselves by young leaves, growing out of the sides of their mother plants; (2) Apetalous seed-bearing water plants.

The account of each genus begins with the etymology of the Latin name followed by a generic description with references to figures and literature. For each species there is a description, place, use, synonomy, and critical remarks. The strange thing is that the account of Class I (six pages) is in English, that of Class II is in Latin. Obviously the work was intended for publication but, though it seems a fair copy, was never finished.

The full account of these additional Dillenian manuscripts will supplement that given by Druce and Vines in their "The Dillenian Herbaria". At the present time, it is interesting to note that the preface to that work dated 1907 ends: "At a time when two great and partly estranged nations are being brought closer together, may this work, insignificant in itself, yet as being compiled in the twentieth century by a British student to bear witness to the eminent service rendered to Botanical science in this country by a German botanist in the eighteenth, be an augury for their more kindly feeling and cordial co-operation in the progress of science".

OXIDATION OF METALS AND THE FORMATION OF PROTECTIVE FILMS*

By Prof. N. F. Mott, F.R.S.,
University of Bristol

A CHEMICAL process in which one of the reacting substances and also the product of the reaction are solid has one feature not shown when the product is gaseous or liquid; the product must necessarily form a barrier between the reacting substances, so that the reaction can only proceed either if the product is continually removed, or if the reacting substances can penetrate the barrier. In the oxidation of metals the rate of the reaction is almost entirely controlled by the rate at which metal or oxygen can penetrate the oxide layer. In general, as the oxide layer becomes thicker, the rate of reaction becomes slower. In some metals, notably aluminium, chromium and probably zinc below 225° C., oxidation stops altogether when the film has reached a thickness of the order of 10^{-6} cm., the protective film thus formed preventing further attack. The discussion of these protective films will be one of the chief purposes of this article.

Provided that one of the reacting substances can penetrate the oxide layer, we would expect that the primary process would be the formation of a fairly uniform film of oxide over the surface of the metal. In many cases, however, it seems certain that the oxide film breaks up as soon as it is formed, and recrystallizes in little islands scattered about the surface. The oxidation of zinc above 225° C. provides an example[1]. The oxide film shows a granular structure under the microscope, and does not show the interference colours obtained with compact oxide films on copper for example. Both facts point to the presence of a conglomerate of fairly large crystals of the type illustrated in Fig. 1(*b*) rather than a compact film. Electron diffraction experiments, moreover, reveal a well-defined crystalline structure.

The tendency of thin films on a substrate to recrystallize is well known, and is shown by the results obtained at Bristol by Appleyard[2], Lovell[3]

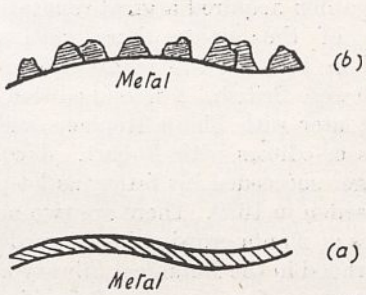

Fig. 1.

(*a*) A COMPACT FILM AND (*b*) A FILM THAT HAS UNDERGONE RECRYSTALLIZATION.

and their co-workers on the conductivity of thin metal films evaporated on glass. Whereas it was found that by repeated degassing of the glass surface, and by depositing the metal at the temperature of liquid air, compact films of rubidium and cæsium could be obtained which would conduct electricity at a thickness corresponding to one or two atomic layers, other metals such as mercury, or alkali metals at higher temperatures, did not conduct until a thickness of about 500 A. was reached. It was concluded that the surface tension of the metal caused the splitting up of the

* Substance of a lecture delivered before the London Branch of the Institute of Physics on April 30.

film and its recrystallization in the form of crystals of about this size. Conductivity would begin when these islands were sufficiently numerous to be in contact with each other.

Vernon and his colleagues found that the weight W of oxide formed on zinc followed the law

$$W = k \log (at + 1), \quad . \quad . \quad (1)$$

or, expressed as a relation between the rate of growth and W,

$$\frac{dW}{dt} = ka.e^{-W/k} ;$$

a was of the order 0·5 (hr.)$^{-1}$. A law of this type gives a rapid initial rate of growth which later becomes vanishingly slow. For example, after 200 hours W will be $2k$, but will reach the value $4k$ only after 20,000 hours. Thus the thicker films must be quite impenetrable to metal or oxygen. The maximum thicknesses obtained are of the order 500 A., the same order as those at which the mercury films conduct. This thickness, however, and hence the size of the individual crystals, increases fairly rapidly as the temperature is raised, as we should expect.

The logarithmic law of growth can be derived on certain assumptions, of which the most important is that the rate of oxidation is proportional to the area of surface not already covered. For the proof the reader is referred to the original papers[4].

We turn now to the compact films formed on copper, iron, aluminium and so on. Two main types can be distinguished: those in which the parabolic law is obeyed, that is to say the weight, and hence the thickness of the film, increase as the square root of the time; so that

$$W = At^{1/2} ; \quad . \quad . \quad (2)$$

and those in which the film grows to a constant thickness d and then practically stops. The oxidation of copper at and above room temperature, of iron[5] above 200°C. and the reaction of silver with the halogens[6] are examples of the first class. The constant A, which determines the growth-rate, increases rapidly with temperature. The protective oxide films formed on such metals as aluminium, chromium and on stainless steels and zinc below 200° are examples of the second class. Here the thickness d which the film reaches seems to be relatively insensitive to temperature. (Experiments to establish this more definitely would be of great interest; the oxide film formed on aluminium at 600° C. in Pilling and Bedworth's work does not seem to be more than ten times heavier than that formed at room temperature. The former film had probably recrystallized.) An example of the second type of growth law is given in Fig. 2.

The explanation of the parabolic law of growth was given some time ago by Tammann[7] and by Piling and Bedworth[8]. It is supposed that either the metal or the oxygen is soluble in the oxide. Let us suppose that the metal is soluble, the excess metal atoms going into interstitial positions in the oxide; then in the oxide in equilibrium with the metal there will be a certain concentration c_0 of excess metal atoms per unit volume. In the oxide film, however, while the reaction is in progress, there will be a concentration gradient of excess metal atoms, the concentration being c_0 at the oxide–metal interface, and zero at the free surface of the oxide, provided that the oxygen has pressure enough to react with the excess metal atoms as soon as they arrive. If x is the thickness of the film, the concentration gradient is thus c_0/x, so that the number N of excess metal atoms crossing unit area per unit time is given by

$$N = Dc_0/x,$$

where D is their coefficient of diffusion. But if Ω is the volume of oxide per metal atom, then the rate of growth dx/dt is equal to $N\Omega$; we thus have

$$\frac{dx}{dt} = \frac{D\Omega c_0}{x}, \quad . \quad . \quad (3)$$

which on integration gives

$$x^2 = 2\,D\Omega c_0 t ; \quad . \quad . \quad (4)$$

this is the required equation.

As equation (3) shows, the rate of growth for very small thicknesses becomes very great. We might expect then, in the initial stages of oxidation, especially at low pressures, that the oxygen pressure would not be sufficient to cause oxidation

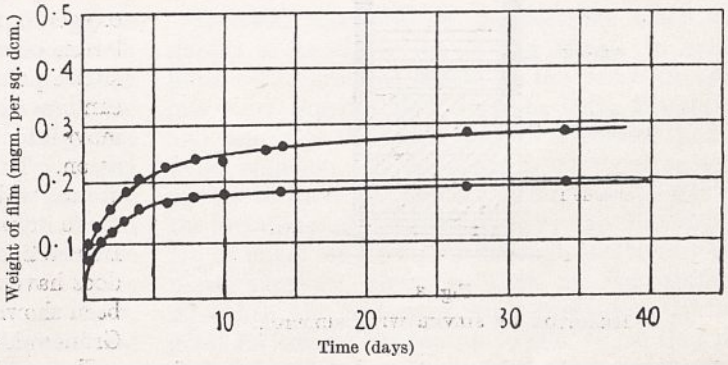

Fig. 2.

FORMATION OF ALUMINIUM OXIDE ON SHEET ALUMINIUM EXPOSED TO THE ATMOSPHERE AT ROOM TEMPERATURE (FROM W. H. J. VERNON, *Trans. Faraday Soc.*, **23**, 113 (1927)).

of the metal atoms as fast as they diffuse to the surface. In the initial stages of growth, then, we should expect a linear rate of growth. Wagner and Grünewald[9] have observed an effect of this type during the oxidation of copper at 1000° C. and a pressure of oxygen equal to that of 1 mm. of mercury. They found that until the film thickness had reached a value of the order 10^{-3} cm. the growth was linear, after which it followed the parabolic law.

We have next to consider whether, during the oxidation of any particular metal, the metal atoms move outwards through the oxide or the oxygen atoms or molecules move inwards. For the reaction of silver with (liquid) sulphur this has been settled experimentally in the following way[10]. Silver was separated from liquid sulphur by *two* slabs of silver sulphide, as shown in Fig. 3. After

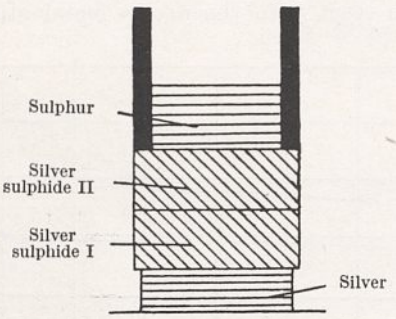

Fig. 3.

REACTION OF SILVER WITH SULPHUR.

the reaction had been allowed to progress for some time, it was found that the upper slab II had increased in weight, but not the lower slab I. This shows that the silver diffuses through the sulphide and that the reaction takes place at the interface between the sulphur and the silver sulphide. If the sulphur were able to diffuse through the sulphide, the reaction would take place partly at the interface between the silver and its sulphide, and the weight of slab I would increase also.

In other cases conclusions may be drawn from the known properties of the oxides, especially from their electrical conductivities. The conductivities of oxides are in general due to the presence of small quantities of oxygen or of the metal constituent in excess of the stoichiometric composition, the excess atoms providing centres which lose an electron easily. The oxides of zinc and aluminium, for example, are what are known as reduction semi-conductors ; that is to say, their conductivity is increased by heating in a vacuum, when a small amount of oxygen is driven off and a corresponding number of metal atoms left behind, probably in interstitial positions. It does not seem possible, however, to produce these oxides with excess oxygen. We may reasonably assume, then, that the oxide film dissolves metal rather than oxygen, and thus that it is the metal ion which moves. An interesting consequence is that, for temperatures and oxygen pressures for which the parabolic law holds, the rate of reaction should be independent of the oxygen pressure for oxides of this type. This follows from equation (4) ; it will be seen that the reaction constant depends on the solubility of the metal only. However, as we shall see below, the parabolic law does not usually hold for this type of oxide.

Cuprous oxide, which is formed when copper is oxidized, is an oxidation semi-conductor ; that is to say, its conductivity increases when it is heated in oxygen, and is due to excess oxygen. There is evidence[11], however, that the oxygen is not taken up interstitially, the oxygen atom being too large to fit into interstitial positions in the oxide lattice. The way in which the lattice accommodates excess oxygen is through the absence from their normal lattice points of a few copper atoms. These vacant lattice points are mobile ; an adjacent metal atom can move into them, and then another atom will move into the position that has been left vacant, and so on. Thus in cuprous oxide also it is the metal atoms which move ; the vacant lattice points move inwards from the oxygen – oxide interface. In reactions of this type, the pressure of oxygen does have an effect on the rate of reaction, as has been shown for the case of copper by Wagner and Grünewald[9].

The oxides of iron form semi-conductors of the same type ; here the concentration of iron may have any value between those given by the formulae FeO and Fe_2O_3.

We do not know of any case of compact oxide films where it is established that the oxygen diffuses.

Wagner has suggested that the atoms diffusing through an oxide layer dissociate almost completely into ions and electrons. If the diffusion takes place through the motion of a vacant lattice point, then by dissociation we mean the following : If, for example, a Cu^+ ion is missing, then a neighbouring Cu^+ or O^{--} ion must have an electron missing, in order that the centre as a whole shall be electrically neutral. At high temperatures, however, the place where the electron is missing may move away from the vacant lattice point by a replacement process. It is suggested, then, that in cuprous oxide the vacant lattice points and the points from which an electron is missing (positive holes) are dissociated.

Estimates of the concentration of excess atoms and of the dissociation energy—the latter determined from the temperature variation of the conductivity of the oxide—enable a theoretical calcu-

lation to be made of the degree of dissociation, and the results bear out the hypothesis. More direct evidence has been obtained by Wagner[9] for the case of copper; he heated cuprous oxide at 1000° C. in oxygen until equilibrium was obtained, and measured the electrical conductivity; he found that it varied as $p^{1/7}$, where p was the pressure of oxygen. This is to be understood in the following way: each oxygen molecule gives two additional oxygen ions (O^{--}) in the Cu_2O lattice, and thus four vacant copper lattice points. If there were no dissociation we should expect the concentration to vary as $p^{1/4}$, if dissociation were complete as $p^{1/8}$, according to the law of mass action. The value obtained suggests that dissociation is nearly complete. As additional evidence, Wagner finds that the rate of oxidation of copper also varies as $p^{1/7}$.

We turn now to the consideration of the protective films formed on aluminium, chromium and other metals. The characteristic feature shown by these films is that they grow fairly rapidly up to a certain critical thickness, after which the growth is very small. The type of thickness-time curve is shown in Fig. 2. Various methods are available for determining the thickness of these very thin films. There is first of all the method of weighing before and during oxidation; this was used by Vernon to obtain the results shown in Fig. 2. To obtain the film thickness from the weight increase one must make an estimate of the true surface area of the surface area of an aluminium sheet. Erbacher[12] gives a ratio of 2·5 between the real and apparent surface, and using this factor we may deduce from Vernon's results a film thickness of 40 A. formed at room temperature. Steinheil[13] also obtained a thickness of 40 A. for the oxide film formed on aluminium after exposure to air for a few months by observing the progressive increase of transparency of evaporated aluminium films exposed to air. Tronstad[14] has used a polarimetric method to estimate the thickness, and gives the following table for films which have reached a constant thickness.

Mercury in dry air	15–20 A.
Aluminium in dry air	100–150 A.
Iron in dry air	15–40 A.
Austenitic stainless steel	10–30 A.

The crystal structure of the oxide films formed on aluminium has been examined by electron diffraction[15] using both reflected and transmitted beams; in the latter case the films were first stripped from the metal substrate. Very diffuse rings are obtained, suggesting that the films are built up of very small crystals. The films are thus to be contrasted with those formed by recrystallization, discussed at the beginning of this article, which give sharp rings. Another difference is that on aluminium, the maximum film thickness varies only slightly with temperature, whereas in the films formed by recrystallization the maximum film thickness increases very rapidly with temperature.

The present author has suggested a theory of the process responsible for the formation of these films[16]. This theory starts from Wagner's hypothesis that metal atoms diffuse through the oxide film in the form of metal ions and electrons separately. Since the films do not grow beyond a thickness of some 40 A. on aluminium, for example, it follows that either the ions or the electrons cannot pass through a thicker layer. It cannot, however, be the ions which find the difficulty, because oxide films thicker than 10,000 A. can be formed on aluminium by anodic oxidation[17], which shows that aluminium ions can pass through the layer if oxide *ions* are supplied at the surface.

It must, therefore, be the electrons which are unable to penetrate the thicker films. In oxide films which grow according to the parabolic law, one must suppose that electrons leave the metal and penetrate the oxide through a kind of thermionic emission; if an electron receives enough energy to leave the metal and move on to one of the metal ions of the oxide, it can jump from metal ion to metal ion and so on through the layer. We must suppose, however, that at the surface $Al-Al_2O_3$ the necessary work function φ is too great for this to happen up to 600° C., so that no emission will take place into a thick oxide film. This implies that $\varphi \geq 2$ ev. It is, however, possible for electrons to pass through a very thin film *without* receiving any energy of activation by what is known as the 'quantum mechanical tunnel effect'. According to the principles of quantum mechanics, it is possible for a particle to penetrate a small distance into regions of high potential energy for which, according to classical mechanics, its kinetic energy is insufficient. The principle has been used to explain, for example, the cold emission of electrons from metals in strong fields, and also the spontaneous α-decay of radioactive nuclei. The number of electrons per second penetrating a film of thickness x turns out to be about

$$10^{23} \quad e^{-4\pi x\sqrt{(2m\phi)}/h} \quad \text{cm.}^{-2}\,\text{sec.}^{-1},$$

giving a maximum rate of growth of the order

$$e^{-4\pi x\sqrt{(2m\phi)}/h} \quad \text{cm./sec.}$$

We may take the effective maximum film thickness to be reached when one atomic layer is added per year; for reasonable values of φ (1 to 2 ev.) this gives a thickness of 30–45 A.

We see, then, that when the oxide is a reduction semi-conductor, incapable of absorbing oxygen, the parabolic law of growth should be observed only if φ is not too large; if φ is large we get a protective film formed. On the other hand, if the oxide can absorb oxygen, the parabolic law will always be valid. Now it has been suggested on various sides[18] that reduction semi-conductors are oxides in which the metal ion has its maximum valency; and actually it appears that it is just oxide films of this type which are protective, namely, Al_2O_3, Cr_2O_3, ZnO. We have very little direct evidence[19] about the values that φ should have for metal – oxide interfaces, but it seems a not unreasonable assumption that φ is in general too large for thermionic emission. If this is the case we shall never get parabolic growth for this type of oxide, but always protective films less than 50 A. thick at low temperatures, and recrystallization leading to a logarithmic law of growth at high temperatures. For oxides such as Cu_2O, FeO, NiO on the other hand, the metal ion does not have its maximum valency, and the oxide can dissolve oxygen. Here we expect a parabolic law of growth producing a uniform film with interference colours. Recrystallization is not excluded for such films, but after it is complete the parabolic growth should continue.

The theory may also be applied to protective films on alloys. We have to note in the first place that protective oxide films can be formed at temperatures at which there is no possibility of metallic diffusion within the alloy. Therefore, when an oxide film is formed, both metals must enter into the oxide layer in the same proportion as that in which they are present in the alloy. That the constitution of the metal underneath the protective layer is the same as in the interior of the metal is also borne out by the fact that successive formations and removals of the protective films do not alter the capacity of the metal to form the films.

On the other hand, quite small additions of the second metal are sufficient to give considerable resistance to corrosion (for example, 7 per cent of aluminium in iron[20], or 3 per cent of aluminium in copper at 800° C.[21]). It is unlikely that 7 per cent of aluminium in ferrous oxide would be sufficient to alter the work function φ of the oxide – iron interface sufficiently to prohibit the passage of electrons. We therefore suggest that initially a mixed oxide is formed, but as the film thickens, the part of the film next to the metal becomes rich in aluminium (or chromium in chromium steels) until it becomes impervious to electrons, while an iron oxide film is formed outside it. The latter film is without influence on the protective properties.

The way in which this may be expected to happen is the following: so far we have considered the metallic ions as leaving the surface layer of the metal and moving in the oxide from one interstitial position to another until they reach the oxide – oxygen interface. Another process will probably occur at the same time; metal ions in an interstitial position will change places with metal ions in the oxide lattice. In an oxide of a single metal this process will not have any observable effect; but in the mixed oxide on steels the divalent ferrous ions will leave their lattice position with the expenditure of less energy than the trivalent aluminium or chromium ions. Therefore, in the layers next to the metal, the ferrous ions will frequently be replaced by the trivalent ions, while mainly ferrous ions will succeed in penetrating to the surface and forming new oxide layers.

It should be emphasized that our theory applies primarily to oxidation at low temperatures at which diffusion of one metal through the alloy is impossible. At high temperatures, on the other hand, it is possible that the proportions of the two metals in the oxide layer may be different from their proportions in the alloy. That this is the case is suggested by experiments of Iitaka and Miyake[22], who find that the protective films formed on copper – beryllium alloys containing one per cent of beryllium heated to a red heat give the electron diffraction rings characteristic of BeO alone. In order to explain these results, we may assume that diffusion within the metal takes place readily, and also that the beryllium ions diffuse through the oxide layer much faster than the larger copper ions, so that a protective film of BeO is formed before any appreciable amount of Cu_2O appears.

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OBITUARIES

Sir Jocelyn Thorpe, C.B.E., F.R.S.

SIR JOCELYN FIELD THORPE died suddenly on June 10 at the White House, Cooden Beach, Sussex. For many years he has been an outstanding and distinguished personality in chemical circles. Born in London on December 1, 1872, he was the sixth son of Mr. W. G. Thorpe of the Middle Temple. He was educated at Worthing College, at King's College, London, at the Royal College of Science, and took a Ph.D. degree in organic chemistry under Victor Meyer at Heidelberg. In 1895 he became research fellow at Owens College, Manchester, where he remained for about fifteen years. Inspired immediately by the magnetic influence of W. H. Perkin, jun., his future career was clear—research was to be the alpha and omega of his life. Alone and jointly he published many papers on subjects which were to serve as the foundation for many of the modern developments in organic chemistry. For four years, from 1909, he transferred to Sheffield, continuing to work on the same subjects as Sorby research fellow of the Royal Society.

The expansion of the Imperial College at South Kensington gave the opportunity to create a full professorship of organic chemistry in 1914. Thorpe held this post until his retirement in 1930, during which period he steadily advanced his reputation for research and teaching: he trained a large number of brilliant students and did much to place Britain in the leading position in organic chemistry which it occupies to-day.

Thorpe's earliest work deals principally with the synthesis of various degradation products derived from the terpenes as well as with cognate problems of aliphatic and alicyclic chemistry; this was published partly with W. H. Perkin, jun. Thorpe was particularly interested in the glutaric and glutaconic acids and their stereochemistry; the latter acids especially provided him with an extremely fruitful field of inquiry, which he exploited to the full after leaving Manchester.

Thorpe's frequent use of ethyl cyanoacetate for synthetic purposes led him to investigate the structure of this compound, and eventually led to the work on the reaction which bears his name. During the Sheffield period he published many papers on the glutaconic acids and produced evidence supporting his "semiaromatic" formula for this compound. This formula, though later abandoned, has points of resemblance with the modern concept of a resonance hybrid and bears testimony to his originality and independence of thought.

After the War of 1914–18, Thorpe's research school underwent a rapid expansion and attracted an enthusiastic band of workers to the Imperial College. Numerous papers dealing with ring formation and with tautomerism appeared in the next few years, although Thorpe's name did not always appear in these memoirs; he left much of the field to his younger collaborators (Ingold, Kon, Farmer, Linstead) and encouraged them to make a name for themselves.

Thorpe's wide knowledge of and abounding interest in chemistry was perhaps the reason why he accepted the task of producing first a Supplement to the "Dictionary of Applied Chemistry" which bears the name of the other Thorpe (Sir Edward) and later a new edition, which is in course of publication. In this he has been assisted by Dr. M. A. Whitely, one of his most loyal colleagues over a long period of years. Thorpe's conception of this dictionary was on the most grandiose scale, and the effort to produce it must be prodigious.

Externally, Thorpe might have been taken for a country squire: he acquired certain little mannerisms which made him resemble what one might describe in the words 'an Edwardian aristocrat'. Actually he was a simple person and though highly cultured and many-sided in his interests, in the main he lived for his research and for the advancement of co-operative chemistry. He was the born committee man and enjoyed serving on these, though he was seldom assertive. Among Government committees he served on the Advisory Council of Scientific and Industrial Research (1916–22); on the Chemical Defence Committee, War Office; as president of the Indian Chemical Services Committee (1919–20); as a member of the Safety in Mines Research Board (1924–25); and as chairman of the Explosives in Mines Committee, Department of Mines, and as a member of the Dye-stuffs Development Committee, Board of Trade (1925–34). He was a member of almost every chemical committee and served as president of both the Chemical Society and the Institute of Chemistry. The former conferred on him the Longstaff Medal in 1921, and the Royal Society gave him the Davy Medal in 1922. He was made C.B.E. in 1917 and knighted last year.

Thorpe made a great effort to unite various chemical interests, and in particular to found a common meeting place in a Chemistry House, but the task proved too difficult. He was undoubtedly happy in his work, and though it may be said that he spread his energies and efforts too widely to leave him time to achieve outstanding success in any one thing, it is probable that his contribution to the common cause, so wholeheartedly and unstintingly given, has over many years had a profound effect in awakening the co-operative spirit among chemists, who perhaps are even more individualistic than the average citizen.

His many friends knew his sterling merits; he understood and appreciated the luxuries in life, was a wonderful host, collected china, possessed a fine chemical library. He was greatly assisted in all he did by his wife, née Lilian Briggs, whom he married in 1902.

E. F. ARMSTRONG.

Sir Thomas Hudson Beare

THOMAS HUDSON BEARE was born at Adelaide, South Australia, on June 30, 1859, and was educated at Prince Alfred College and the University of Adelaide. After obtaining the B.A. degree he was awarded the Fife (Australia) scholarship, and he then proceeded to London, where he studied at University College and obtained the B.Sc. degree of the University of London.

Before leaving Australia, Hudson Beare held an appointment in the Public Works Department, and was engaged on railway construction, and after completion of the London degree he had further practical experience in the Midlands and in Manchester.

In 1884 he was invited to join the staff at University College, London, and for three years assisted Prof. A. B. W. Kennedy in teaching and in private professional work. In a testimonial written in his favour at the end of that period, Prof. Kennedy commented on his ability as a teacher and an organizer, on his knowledge and skill as an engineer. Shortly afterwards, Hudson Beare was appointed to the chair of mechanics and engineering in the Heriot-Watt College, Edinburgh. He was the first occupant of this chair, and in two years he built up a most successful department.

In 1889, on the resignation of Prof. Kennedy, he was appointed to the chair of engineering at University College, London, and was very largely responsible for the planning and equipment of the new Engineering Department which was built in 1895. During this period, in addition to his normal duties, he was able to carry out a considerable amount of research work, and was awarded the Telford Premium by the Institution of Civil Engineers for a valuable paper on "The Building Stones of Great Britain". As a member of the Research Committees on Steam Jackets and on Marine Engine Trials, he published several papers in the *Proceedings* of the Institution of Mechanical Engineers.

In 1901 Hudson Beare was appointed regius professor of engineering at the University of Edinburgh. The Engineering Department of that time was small, poorly equipped and very inadequately housed, but under Hudson Beare's energizing influence the number of students rapidly increased, and in 1905 the Department was accommodated in new and well-equipped premises. So successful was he that the Edinburgh school attracted students from all parts of the Empire, from the Continent, from China and South America, and it was again found that the accommodation was inadequate. Once more Sir Thomas undertook the design of new laboratories, and in 1931 the Department was transferred to the Sanderson Engineering Laboratories at King's Buildings.

In 1913 Sir Thomas was elected dean of the Faculty of Science at Edinburgh, a post which he held until his death on June 10 last, and his expert knowledge and great administrative ability enabled him to render invaluable service to the University. For many years he was convener of the Works Committee of the University Court, and carried the enormous responsibility of supervising the erection of many new departments and of the many alterations required to adapt the older buildings to modern requirements. In 1908 he was appointed convener of the Military Education Committee of the University, and his keen interest in military affairs was largely instrumental in raising the Edinburgh University contingent of the Officers Training Corps to its high state of efficiency. He also represented the University as a member of the City of Edinburgh Territorial and Air Force Association, and for a period acted as chairman.

Sir Thomas acted for several terms as vice-president of the Royal Society of Edinburgh, was vice-president of the Board of Governors of the Edinburgh and East of Scotland College of Agriculture from 1932, chairman of the Board of Governors of the Royal (Dick) Veterinary College from 1923, and for many years a governor of the Heriot-Watt College. In 1921 he was appointed by the Secretary of State for Scotland as an assessor on the Central Miners' Welfare Committee, and served on the Commission until the time of his death. His knighthood was conferred upon him in 1926, and ten years later he received the honorary degree of LL.D. from the University of Edinburgh. He was a member of the Institution of Civil Engineers, a member and later an honorary life member of the Institution of Mechanical Engineers, and a member and vice-president of the Institution of Structural Engineers. He was a justice of the peace and Deputy Lieutenant of the County of the City of Edinburgh.

A man of outstanding ability, Sir Thomas's interest lay not in himself but in the work which came to his hands. In the later period of his service his many administrative duties compelled him, of necessity, to give up research work but never prevented him from keeping closely in touch with the latest developments in engineering. Throughout all the years he was able to continue his clear and logical teaching in his own department. Keenly interested as he was in students and in all their activities, it is not surprising that he won their regard and confidence, and this was reflected in the close associations they maintained with him in after-life. He was not merely a teacher of engineering and a great figure in the profession to which they belonged, but also one who inspired them with a sense of conscientiousness, of honour and of integrity in the carrying out of the duties of life. During these almost incredibly busy years relaxation was found in travel and in the study of Nature, but even in recreation his alertness of mind asserted itself, and he was accepted by entomologists as an authoritative specialist on the systematics of the Coleoptera. J. B. TODD.

Dr. Matthew Young

WE regret to record the death of Dr. Matthew Young, anatomist and anthropologist, which took place on May 25 at the age of fifty-six.

Matthew Young was born in Ayrshire and educated at Kilmarnock Academy and the University of

(*Continued on page* 1011)

NATURE

SUPPLEMENT

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SHORT REVIEWS

Agriculture and Forestry

A Text-Book of Agriculture

Designed for use in East African Schools. By J. G. Brash. Pp. xv+311. (London: The Sheldon Press, 1939.) 4*s*. 6*d*.

THE writing of a text-book of agriculture in English for use by a body of students whose knowledge of English is very meagre is surely a most difficult task. This is evidently realized by the author of the present book, for he includes a glossary not only of technical terms but also of words and expressions commonly in use in ordinary English. But if the task of preparing such a text-book must be faced, we have seen no attempt which attains a greater measure of success than that now under consideration. Apart from the language difficulty in the present case, there is another, which is referred to in the author's foreword, namely, that the pupils for whom it is designed look upon the study of agriculture in the schools as a disagreeable necessity, for most of them join the higher schools chiefly for the purpose of gaining a higher social status by getting remunerative employment on the completion of their school courses, and hence are in most cases only interested in those subjects which are required for such paid positions as are available to them.

Yet, in a country of which the whole economic future depends on agricultural progress, the latter must chiefly come through the younger generation who are now in the schools. It would seem, therefore, that if these young people are really to be weaned from the desire for mere clerical positions to a genuine devotion to the improvement of agriculture, there must be text-books which are of exceptional interest, and also inspiring teachers of the subject in the schools. Without the latter, the text-book will do little: with them, it would not be easy to prepare a better book than that under review.

In it, the principles of agriculture as applied to East African conditions are admirably presented, with emphasis on those matters which have proved to be the most important for the development of the country. Special features are the very lucid account of erosion and the methods of combating it, and a useful chapter on the co-operative organization of agriculture as it can be developed in East Africa.

The book can be highly recommended. It does almost all that a text-book can do in connexion with agricultural teaching in East Africa, but neither it nor any other text-book can direct interest and attention back to agriculture in the absence of an inspiring teacher. If the latter is there, then the book will be found of great value. H. H. M.

Timber

Its Properties, Pests and Preservation. By Dr. F. Y. Henderson. Pp. 186+19 plates. (London: Crosby Lockwood and Son, Ltd., 1939.) 9*s*. 6*d*. net.

NUMEROUS technical publications have been issued which deal separately with different aspects of timber technology, but none has appeared in Great Britain in which a general elementary account of timber in non-technical language is given. The book under notice, written primarily for students of engineering and building science, fills this gap. The text covers briefly the whole general field of timber technology as indicated under its sub-titles, and is profusely illustrated with line drawings and photographs, the majority of which are original. The style is refreshingly simple and straightforward, thus bearing the hall-mark of an author who not only knows his subject, but also has the gift of being able to put himself into the position of the student and general reader who is taking up the subject for the first time.

This book should prove of great value not only to engineering and building students, but also to the general public, all of whom are users of timber. In war-time it is important that the most economical use be made of our timber resources, and it is only through knowledge of its properties that it can be used most profitably. It is unfortunate that the price may put this book out of reach of many, but this is doubtless due to the general rise in cost of production, but to those who can afford it the nine shillings and sixpence should prove an excellent investment. K. St. G. C.

Soil Analysis

A Handbook of Physical and Chemical Methods. By C. Harold Wright. Second edition. Pp. x+276. (London: Thomas Murby and Co.; New York: D. Van Nostrand Co. Inc., 1939.) 12*s*. 6*d*. net.

THE first edition of this book, although written particularly for those who have not the facilities of a good library, proved a useful addition to the bookshelves of most agricultural chemists. In this revised edition the author has replaced methods of analysis that were becoming out of date or of only minor importance by new ones. Some fresh sections have been added dealing with the freezing point, glass electrode, inorganic soil colloids and methods for the determination of cobalt and zinc. To the section on carbon the Ter Meulen dry combustion method has been added, together with a summary of the report of the Organic Carbon Committee of the International Society of Soil Science. This Committee compared a number of methods for determining carbon in soils, and the results and experiences of the analysts should be useful to soil chemists.

In presenting the chemical methods of analysis in his book the author has divided them into general and special methods, but the reviewer suggests that this grouping is not entirely satisfactory, since the ordinary Kjeldahl method for nitrogen and common methods for carbon are to be found under special methods, whereas the determinations of phosphoric acid and potassium appear in the general class. This is only a very minor criticism, and in no way detracts from the value of the book.

R. G. WARREN.

Anthropology and Archæology

James George Frazer

The Portrait of a Scholar. By R. Angus Downie. Pp. ix+141. (London: Watts and Co., Ltd., 1940.) 5*s*. net.

THIS "portrait of a scholar" is drawn by one who now for a number of years has been associated with Sir James Frazer's work. That association has been fruitful in producing the supplementary volumes of "The Golden Bough" and "Totemism", as well as the five volumes of selected extracts from the notebooks which bear testimony to the life-long and unremitting industry which Sir James has devoted to the commendable practice of note-making. A further outcome of this association is that it has given Mr. Downie an acquaintance, intimate and unrivalled, with the lines of every branch of investigation upon which Sir James has brought his genius to bear, as well as a clear insight into the working of his mind, so far as that is possible when dealing with a subject who both as an individual and as author exhibits in a supreme degree the scholar's qualities of balance and restraint.

Sir James Frazer's life-history is the story of his work; and he lives in his books. For the benefit of those who may know but little of that work, who perhaps have come into touch with only one aspect of it, or indeed may not know it at all, Mr. Downie has sketched a portrait of a many-faceted mind, and of what, had Sir James been a man of action, would have been termed justly a life of adventure in many fields. For in the realms of the mind Sir James has been a traveller in many remote tracts and untrodden ways, a pioneer and explorer in the dark ways of humanity. Chapter by chapter, Mr. Downie guides the reader, assisting his steps with illuminating quotation, from Sir James's early work at Cambridge and his association with Robertson Smith to "The Golden Bough", to "Totemism" and to "The Folklore of the Old Testament", to name the more important only among his monumental contribution to the comparative study of the human mind, its beliefs and the institutions to which it gives rise. But these, though the best known, do not complete the tale of his activities. In addition, there are the classical studies by which he first earned his right of entry to the learned world and produced his "Pausanias" and the "Fasti" of Ovid, border-line works; and there are also those purely literary studies of Cowper and Addison and the other 'pieces' in which some hold Sir James has risen to the highest point of that stylistic excellence which Mr. Downie rightly stresses throughout.

The Illusion of National Character

By Hamilton Fyfe. Pp. v+274. (London: Watts and Co., 1940.) 8*s*. 6*d*. net.

MR. HAMILTON FYFE sets out to destroy the generalizations about peoples—mainly the illusion of national character—which in past and current discussion obscure counsel. While some generalizations about large groups are possible, is it true that general statements about Englishmen, Frenchmen or Germans are valid, apart from affirmation of such externals as membership of a particular State, geographical habitat or language? Is there over and above these such a thing as national character? As will be gathered from his title, in the judgment of the author there is not. Even though he is prepared to concede certain differences due to surroundings, he would maintain that, beneath, these peoples are alike. On this it may be remarked that while this may be true of race in a biological sense and the so-called 'racial theory' a delusion, when it is not a fraud, national character stands in a different category. The cumulative effect of cultural continuity, viewed historically, cannot be ignored; any attempt to do so will be no less disastrous than the exaggerated nationalism which has brought about the War.

Biology

Graptolithina

Von O. M. B. Bulman. (Handbuch der Paläozoologie, herausgegeben von O. H. Schindewolf, Lieferung 2, Band 2D.) Pp. iii+92. (Berlin: Gebrüder Borntraeger, 1938.) 13 gold marks.

THIS is the first part to be published of a comprehensive treatise on palæozoology. The general plan is similar to that of Zittel's great "Handbuch" (1876–93), but whereas that work was in four volumes

and, with the exception of the parts on Insecta and Myriapoda, was written entirely by von Zittel, this new work is to consist of twenty volumes by nearly fifty specialists.

In this part, Dr. Bulman gives a masterly account of the Graptolithina. Each of the two main divisions, the Dendroidea and the Graptoloidea, is considered under the headings: diagnosis, morphology, development, ecology, distribution, phylogeny and systematics. There is no separate section on the history of the subject, but the development of knowledge is indicated in each section of the work. The illustrations are numerous, and those showing morphology and development are especially noteworthy. In the systematic part diagnoses are given of all the known genera. It is to be regretted that the outstanding work of Kozlowski could only be considered briefly in a postscript. His discovery in the Upper Tremadoc, south of Warsaw, of the most perfectly preserved Dendroids yet known has led him to the conclusion that the Graptolites are not hydroids, but are closely related to the Pterobranchia among the Hemichordata. This is supported by the presence among the Graptolites of a Pterobranch allied to the living Cephalodiscus.

Elementary Microtechnique

By H. Alan Peacock. Second edition. Pp. viii+330. (London: Edward Arnold and Co., 1940.) 9*s*.

REASONABLY priced, compact, well bound and clearly written, this book surpasses the high standard already set by the author in the first edition. There are chapters on the microscope and its use, methods of making preparations of animal and plant tissues, methods of wax-embedding, formulæ, sources and culture of material, preservation of material, etc.; while more than a hundred pages are devoted to methods of dealing with specific material, both plant and animal. There are also an excellent little bibliography and a list of dealers from whom amateurs or schools not favourably situated can obtain enough to satisfy the most exacting student of the microscope. The author has done well to set out his practical instructions line by line in numbered sequence, adding the length of time for applying each reagent and giving a number of alternative methods. For the next edition, the author should consider omitting the chapter on the protoplasm and the cell (too short to be of great use) and substitute a few pages on the cultivation of microscopic fungi, with details of various nutrient media in common use. All students and teachers of biology owe thanks to Mr. Peacock for this excellent little compendium; for its scope there is none better.

Food Values at a Glance

And How to Plan a Healthy Diet. By Violet G. Plimmer. Second edition. Pp. 190. (London, New York and Toronto: Longmans, Green and Co., Ltd., 1939.) 6*s*. net.

MODESTLY disclaiming any expert knowledge of nutrition, Mrs. Plimmer has launched the second edition of this useful little work at a time when, as she herself puts it, there is opportunity to recast and modernize our defences on the food front. Her disclaimer is misleading if by the knowledge of nutrition we understand a knowledge of how properly to nourish the body, because here are all the essential facts clearly presented and in very readable form. Although I do not think every reader will find Mrs. Plimmer's "Neapolitan Ice" method of portraying the composition of foods as convenient to refer to as the more customary tables, it at least lends colour to the commonsense account she gives of up-to-date views on diet in relation to health and fitness. At a time such as the present this handy little work should be widely read. J. C. D.

The World of Insects

By Prof. Carl D. Duncan and Prof. Gayle Pickwell. Pp. ix+409. (New York and London: McGraw-Hill Book Co. Inc., 1939.) 21*s*.

THIS book is one of the best elementary manuals on insect life that has appeared during recent years in the United States. It is well adapted for the general reader or the student-beginner, since technicalities are reduced to a minimum and the subject is attractively presented without a noticeable tendency to be unduly popular. While sufficient grounding in structure and classification is given, the book, in the main, is concerned with living animals, and more attention is shown to such matters as life, growth, behaviour, food, locomotion, etc. There is also a useful chapter on injurious insects and the means for their control. The illustrations are very good and original, and comprise both line and half-tone examples. Many of the latter are really effective results of the expert use of photography.

Calluna

A Monograph on the Scotch Heather. By W. Beijerinck. (Verhandelingen der Koninklijke Nederlandsche Akademie van Wetenschappen, Afdeeling Natuurkunde, Sectie 2, Deel 38, No. 4.) Pp. 180+30 plates. (Amsterdam: N. V. Noord-Hollandsche Uitgevers Maatschappij, 1940.) 7.50 fl.

IN view of the great importance of Calluna in diverse types of vegetation, a monograph, which aims at bringing together all that is known about this plant, will be very welcome to the ecologist. The author has sifted a large volume of literature and, where needful, has supplemented available information by his own investigations so that information on a wide diversity of topics is provided. Considerable space is devoted to a consideration of external and internal structure, as well as of the life-history, and this is copiously illustrated. Occasional points are obscure; for example, it is difficult to follow the data on cork-development on p. 34. On the ecological side the monograph falls a little short of the ideal. Thus, there is but little information on such topics as rooting depth, seedling mortality, and regeneration after fire, while the British reader would no doubt seek more data than are afforded on the vegetation-types in which Calluna plays a part. The subject-matter is well arranged, but for a treatise of this size some kind of index would have been desirable. F. E. F.

Engineering

The Engineer's Year-Book of Formulæ, Rules, Tables, Data and Memoranda for 1940

A Compendium of the Modern Practice of Civil, Mechanical, Electrical, Marine, Gas, Aero, Mine and Metallurgical Engineering. Originally compiled by H. R. Kempe and W. Hanneford-Smith. 46th annual issue, revised under the direction of L. St. L. Pendred. Pp. lxi+xii+2788. (London: Morgan Brothers (Publishers), Ltd., 1940.) 31*s.* 6*d.* net.

SUBSTANTIALLY the same publication in the form in which it has appeared for a number of years, "Kempe's Engineer's Year-Book" has been issued in its 1940 edition. Though once again in its forty-six years' history it has been published in time of war, this fact has not changed its form or restricted the great range of the information it presents. A few changes there have been, but these are in the nature of those developments which must necessarily take place in a work of this kind in order to keep it up to date and to maintain its usefulness at a maximum. The section dealing with the costs of engineering works has therefore been excised, for at the time of preparation it was apparent that the prospects of war negatived its value for so long as conditions should remain abnormal. The space thus released has been occupied with some of the mathematical tables which were discarded a few years ago so that the bulk of the volume might be limited.

The original aim of its first editor to produce a work which, being carefully brought up to date, shall take its place as the standard book of reference in the profession is fully maintained in the latest issue. The list of associate editors and contributors, forty-six in number and each responsible for the preparation of a section, contains the names of recognized experts, most of them engineers, and the section dealing with timbers has been revised by the Forest Products Research Laboratory. The user can therefore feel fully confident that the information given throughout its pages is in the highest degree reliable. In a way, it appears at a psychological moment, for with the whole engineering profession of Great Britain organizing itself for its duties in the War, and its members engaged in new work, the need for such a work of reference is greatly enhanced.

The Engineers' Manual

By Prof. Ralph G. Hudson. Second edition. Pp. iv+340. (New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1939.) 13*s.* 6*d.* net.

PROF. HUDSON'S book contains what may be regarded as the 'permanent information' of engineering. It comprises a consolidation of the principal formulæ and tables of mathematics, mechanics, hydraulics, heat and electricity in frequent use by practising engineers and engineering students. As each set of formulæ is preceded by a statement giving its application, the physical quantities involved and the units of measurement used, the appropriate formula is quickly selected and accurate substitution readily effected. The sequence in which the formulæ are arranged is, so far as possible, that of the order of derivation, so that, where it may be required, the source of any statement can be recognized from an inspection of those immediately preceding it.

Geography and Travel

The Scenery of Sidmouth

Its Natural Beauty and Historic Interest. By Dr. Vaughan Cornish. Pp. xiii+86+6 plates. (Cambridge: At the University Press, 1940.) 7*s.* 6*d.* net.

NO one has raised his voice more frequently or with greater sincerity for the preservation of the beauties of rural England than Dr. Vaughan Cornish. To him, as indeed to many others, the charm of our English countryside is one of the priceless heritages of the land, and he says with truth that sorrow is softened and hope strengthened by the peaceful beauty of rural England. In earlier works Dr. Cornish has tried to establish general principles for the æsthetics of scenery. In this small book he illustrates these principles by the analytical description of a small area. The corner of South Devon he has chosen is one of long family associations; and he has been able to give practical expression in it to his desire for preserving beauty in saving the valley of Salcombe Regis from spoliation by the builder. It is a charming volume, which shows the mingling of scientific spirit and æsthetic appreciation in the manner that the author has made all his own, and it provides at very least an hour or two of soothing comfort in these dire days. There are charming illustrations and an excellent map.

The Statesman's Year-Book

Statistical and Historical Annual of the States of the World for the Year 1940. Edited by Dr. M. Epstein. Seventy-seventh annual publication: revised after Official Returns. Pp. xxxviii+1488. (London: Macmillan and Co., Ltd., 1940.) 20*s.* net.

EVEN in these difficult times this annual statistical review of the world appears, not merely with regularity, but also with all its usual features and at the usual price. The task of revision has presented many obstacles, and for several States the discontinuance of official statistics has been a drawback. Yet the picture of the world in the opening quarter of this year is wonderfully complete. States now in enemy occupation appear in their rightful places: thus Poland, and Danzig, as well as the later occupied western States, retain their nominal independence. Czechoslovakia and Albania also have their places, but Ethiopia is submerged. Even the League of Nations still figures, but the list of non-members is now a long one. The useful introductory tables give world production of petroleum, cotton, iron and steel, gold and rubber. A coloured folding map shows the extent of the U.S.S.R. with indications of the various degrees of autonomy, 'protection' and influence attributed to the different constituent States and territories.

RECENT SCIENTIFIC AND TECHNICAL BOOKS

Volumes marked with an asterisk (*) have been received at "NATURE" Office

Mathematics : Mechanics : Physics

Bennett, C. M. Easy Mathematics. Book 1. Ex. Cr 8vo. Pp. vi +138. (London, Glasgow and Bombay : Blackie and Son, Ltd., 1940.) 1*s.* 9*d.* ; with Answers 2*s.* 3*d.*

Borel, Émile, et **Chéron, André.** Théorie mathématique du Bridge à la portée de tous. (Monographies des probabilités, Fascicule 5.) Roy. 8vo. Pp. xviii +392. (Paris : Gauthier-Villars, 1940.) 175 francs.*

Dugas, R. Essai sur l'incompréhension mathématique. 8vo. Pp. 132. (Paris : Libr. Vuibert, 1940.) 25 francs.

Fielding, T. J. Photo-Electric and Selenium Cells. Second edition. Ex. Cr. 8vo. Pp. vii +163. (London : Chapman and Hall, Ltd., 1940.) 7*s.* 6*d.* net.

Harrison, George Russell. Atoms in Action : the World of Creative Physics. Demy 8vo. Pp. x +370 +16 plates. (London : George Allen and Unwin, Ltd., 1940.) 12*s.* 6*d.* net.*

Hymans, J. C. S. Simple Mathematics for Gunner Officers. Cr. 8vo. Pp. xi +39. (London : Gale and Polden, Ltd., 1940.) 1*s.* 6*d.*

Kármán, Theodore v., and **Biot, Maurice A.** Mathematical Methods in Engineering : an Introduction to the Mathematical Treatment of Engineering Problems. Med. 8vo. Pp. xii +505. (New York and London : McGraw-Hill Book Co., Inc., 1940.) 26*s.**

Lindsay, Robert Bruce. General Physics : for Students of Science. Med. 8vo. Pp. xiv +534. (New York : John Wiley and Sons, Inc. ; London : Chapman and Hall, Ltd., 1940.) 22*s.* 6*d.* net.*

Littlewood, Dudley E. The Theory of Group Characters and Matrix Representations of Groups. Roy. 8vo. Pp. viii +292. (Oxford : Clarendon Press ; London : Oxford University Press, 1940.) 20*s.* net.*

Lloyd, Ll. S. The Musical Ear. Demy 8vo. Pp. ix + 88 +2 plates. (London, New York and Toronto : Oxford University Press, 1940.) 6*s.* 6*d.* net.*

Lyness, R. C., and **Milford, Michael.** Simple Algebra. Cr. 8vo. Pp. 199. (London : Edward Arnold and Co., 1940.) 3*s.* ; with Answers, 3*s.* 6*d.*

Manfield, G. W. Essential Arithmetic. Cr. 8vo. Book 1. Pp. 80. 1*s.* 3*d.* Book 2. Pp. 80. 1*s.* 3*d.* (London : Edward Arnold and Co., 1940.)

Mott, N. F., and **Gurney, R. W.** Electronic Processes in Ionic Crystals. (International Series of Monographs on Physics.) Roy. 8vo. Pp. xii +276. (Oxford : Clarendon Press ; London : Oxford University Press, 1940.) 20*s.* net.*

Spectroscopy. Proceedings of the Seventh Summer Conference on Spectroscopy and its Applications, held at the Massachusetts Institute of Technology, Cambridge, Massachusetts, July 17–19, 1939. (A publication of the Technology Press, Massachusetts Institute of Technology.) Cr. 4to. Pp. viii +154. (New York : John Wiley and Sons, Inc. ; London : Chapman and Hall, Ltd., 1940.) 16*s.* 6*d.* net.*

Strong, John ; in collaboration with **Neher, H. Victor ; Whitford, Albert E. ; Cartwright, C. Hawley,** and **Hayward, Roger.** Modern Physical Laboratory Practice. Med. 8vo. Pp. x +642. (London, Glasgow and Bombay : Blackie and Son, Ltd., 1940.) 35*s.* net.*

Engineering

Agg, Thomas Radford. The Construction of Roads and Pavements. Fifth edition. Med. 8vo. Pp. xiv +483. (New York and London : McGraw-Hill Book Co., Inc., 1940.) 26*s.*

Albert, Arthur Lemuel. Electrical Communication. Second edition. Med. 8vo. Pp. ix +534. (New York : John Wiley and Sons, Inc. ; London : Chapman and Hall, Ltd., 1940.) 30*s.* net.*

Atherton, William H. Hoisting Machinery. Med. 8vo. Pp. xii +314. (London : The Technical Press, Ltd., 1940.) 32*s.* 6*d.* net.

Beckett, C. S. Generation and Transmission. Med. 8vo. Pp. 118. (London, Glasgow and Bombay : Blackie and Son, Ltd., 1940.) 5*s.* net.

Canfield, Donald T. The Measurement of Alternating Current Energy. Demy 8vo. Pp. xi +210. (New York and London : McGraw-Hill Book Co., Inc., 1940.) 12*s.*

Department of Scientific and Industrial Research. Sound Transmission in Buildings : Practical Notes for Architects and Builders. By R. Fitzmaurice and William Allen. Roy. 4to. Pp. viii +50. (London : H.M. Stationery Office, 1939.) 4*s.* net.*

Department of Scientific and Industrial Research : Building Research. Wartime Building Bulletin No. 1 : Economical Type Designs in Structural Steelwork for Single Storey Factories. Demy 4to. Pp. 30. 1*s.* net. Wartime Building Bulletin No. 2 : The Application of Reinforced Concrete to Wartime Building. Demy 4to. Pp. 10. 6*d.* net. (London : H.M. Stationery Office, 1940.)*

Grinter, L. E. Automatic Design of Continuous Frames in Steel and Reinforced Concrete. Med. 8vo. Pp. viii + 141. (New York : The Macmillan Company, 1939.) 12*s.* 6*d.* net.

Neill, Humphrey B. Forty-Eight Million Horses. Med. 8vo. Pp. 253. (Philadelphia and London : J. B. Lippincott Co., Inc., 1940.) 12*s.* 6*d.* net.

Sadler, Walter C. Legal Aspects of Engineering. Med. 8vo. Pp. xix +631. (New York : John Wiley and Sons, Inc. ; London : Chapman and Hall, Ltd., 1940.) 24*s.* net.*

Smalley, M. F. ; Prentice, A. N. ; Buck, H. E. ; Wright, W. J. ; Kelch, R. V. ; Lucal, C. L. ; and **Bernhard, G. K.** Practical Electric Metering. Med. 8vo. Pp. vii +228. (New York : John Wiley and Sons, Inc. ; London : Chapman and Hall, Ltd., 1940.) 16*s.* 6*d.* net.*

Chemistry : Chemical Industry

Bray, William C., and **Latimer, Wendell M.** A Course in General Chemistry. Third edition. Demy 8vo. Pp. xii +206. (New York : The Macmillan Company, 1940.) 7*s.* 6*d.*

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Gordon, Neil E., and **Trout, Jr., William E.** Introductory College Chemistry. Second edition. Med. 8vo. Pp. xiii +753. (New York : John Wiley and Sons, Inc. ; London : Chapman and Hall, Ltd., 1940.) 21*s.* net.*

Kingzett's Chemical Encyclopædia : a Digest of Chemistry and its Industrial Applications. Revised and edited by Ralph K. Strong. Sixth edition. Med. 8vo. Pp. x +1088. (London : Baillière, Tindall and Cox, 1940.) 45*s.**

Rice, Oscar Knefler. Electronic Structure and Chemical Binding : with Special Reference to Inorganic Chemistry. Med. 8vo. Pp. xiv +511. (New York and London : McGraw-Hill Book Co., Inc., 1940.) 33*s.**

Sand, Henry J. S. Electrochemistry and Electrochemical Analysis : a Theoretical and Practical Treatise for Students and Analysts. Vol. 2 : Gravimetric Electrolytic Analysis and Electrolytic Marsh Tests. Cr. 8vo. Pp. ix +149. (London, Glasgow and Bombay : Blackie and Son, Ltd., 1940.) 5*s.* net.*

Snell, Foster Dee, and **Snell, Cornelia T.** Chemicals of Commerce. Demy 8vo. Pp. viii +542. (London : Chapman and Hall, Ltd., 1940.) 28*s.* net.*

Technology

Charles, David. Photographic Enlarging. Cr. 8vo. Pp. 101. (London : Iliffe and Sons, Ltd., 1940.) 3*s.* 6*d.* net.

Davey, H. T. Wood Finishing. Demy 8vo. Pp. viii + 224. (London : Sir Isaac Pitman and Sons, Ltd., 1940.) 12*s.* 6*d.* net.

Department of Scientific and Industrial Research : Building Research. Technical Paper No. 27 : Investigations on Pozzolanas, 1 : Pozzolanas and Lime-Pozzolana Mixes. By F. M. Lea. Roy. 8vo. Pp. iv +64. (London : H.M. Stationery Office, 1940.) 1*s.* net.*

Jenny, A. The Anodic Oxidation of Aluminium and its Alloys. Translated by Winifred Lewis. (Griffin's Technological Handbooks.) Med. 8vo. Pp. vii +231. (London : Charles Griffin and Co., Ltd., 1940.) 16*s.* net.*

Kerry, W. H., Written and illustrated by (in collaboration with **Stott, E. W.**) Freehand Drawing and Pictorial Illustration for Draughtsmen. Demy 8vo. Pp. 50. (Epsom : The Draughtsman Publishing Co., Ltd., 1940.) 2*s.* net.*

Kinzel, A. B., and **Franks, Russell.** The Alloys of Iron and Chromium. Vol. 2 : High-Chromium Alloys. (Alloys of Iron Research : Monograph Series.) Med. 8vo. Pp. xv +559. (New York and London : McGraw-Hill Book Co., Inc., 1940.) 40*s.*

Matthias, A. J. How to Design and Instal Plumbing. 8vo. Pp. 388. (London : The Technical Press, Ltd., 1940.) 18*s.* net.

Townsend, Gilbert. Stair Building, Design and Construction. 8vo. Pp. 200. (London : The Technical Press, Ltd., 1940.) 12*s.* net.

Astronomy

Draper, Arthur L., and **Lockwood, Marian.** The Story of Astronomy. Demy 8vo. Pp. xi +394 +28 plates. (London : George Allen and Unwin, Ltd., 1940.) 12*s.* 6*d.* net.*

Russell, Henry Norris, and **Moore, Charlotte E.** The Masses of the Stars : with a General Catalogue of Dynamical Parallaxes. (Astrophysical Monographs, sponsored by the *Astrophysical Journal.*) Sup. Roy. 8vo. Pp. ix +236. (Chicago : University of Chicago Press ; London : Cambridge University Press, 1940.) 21*s.* net.*

Meteorology : Geophysics

Benstead, C. R. The Weather Eye. Ex. Cr. 8vo. Pp. 287. (London : Robert Hale, Ltd., 1940.) 8*s.* 6*d.* net.

British Museum (Natural History). John Murray Expedition, 1933–34. Scientific Reports, Vol. 3, No. 4 : The Distribution of Organic Carbon and Nitrogen in Sediments from the Arabian Sea. By John D. H. Wiseman and H. Bennett. Roy. 4to. Pp. 193–222. (London : British Museum (Natural History), 1940.) 2*s.* 6*d.*

Fisk, Dorothy. The Sun, the Sky and Kit. Ex. Cr. 8vo. Pp. 240. (London : Faber and Faber, Ltd., 1940.) 8*s.* 6*d.* net.*

Geology : Mineralogy

Smith, G. F. Herbert. Gemstones. Ninth edition, rewritten. Demy 8vo. Pp. xvii +444 +42 plates. (London : Methuen and Co., Ltd., 1940.) 18*s.* net.*

Walton, John. An Introduction to the Study of Fossil Plants. Roy. 8vo. Pp. x +188. (London : Adam and Charles Black, Ltd., 1940.) 15*s.* net.*

Geography : Travel

Bernard, Theos. Land of a Thousand Buddhas : a Pilgrimage into the Heart of Tibet and the Sacred City of Lhasa. Med. 8vo. Pp. 320. (London : Rider and Co., 1940.) 18*s.* net.

Cornish, Vaughan. The Scenery of Sidmouth : its Natural Beauty and Historic Interest. Demy 8vo. Pp. xiii +86 +6 plates. (Cambridge : At the University Press, 1940.) 7*s.* 6*d.* net.*

Epstein, M., Edited by. The Statesman's Year-Book : Statistical and Historical Annual of the States of the World for the Year 1940. Seventy-seventh annual publication : revised after Official Returns. Cr. 8vo. Pp. xxxviii +1488. (London : Macmillan and Co., Ltd., 1940.) 20*s.* net.*

Helbronner, Paul. Tables générales des quatorze éléments (douze tomes, deux albums annexes) de la description géométrique détaillée des Alpes françaises. Roy. 4to. Pp. 353–1192. (Paris : Gauthier-Villars, 1939).*

Ludwig, Emil. The Nile. Translated by Mary H. Lindsay. Cheap edition. Demy 8vo. Pp. 687. (London : George Allen and Unwin, Ltd., 1940.) 15*s.* net.

Mee, Arthur, Edited by. Norfolk. (The King's England, a New Domesday Book of 10,000 Towns and Villages.) Ex. Cr. 8vo. Pp. x +487. (London : Hodder and Stoughton, Ltd., 1940.) 10*s.* 6*d.* net.

Parrish, Maud. Nine Pounds of Luggage. Med. 8vo. Pp. 334. (London : Hutchinson and Co., Ltd., 1940.) 18*s.* net.

Ponder, S. E. G. India of the Rajahs. Demy 8vo. Pp. 256. (London : Stanley Paul and Co., Ltd., 1940.) 16*s.* net.

Potts, W. H. Wind From the East. Demy 8vo. Pp. 244. (London, Glasgow and Bombay : Blackie and Son, Ltd., 1940.) 10*s.* 6*d.* net.

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Thompson, R. W. Voice From the Wilderness. Ex. Cr. 8vo. Pp. 360. (London : Faber and Faber, Ltd., 1940.) 12*s.* 6*d.* net.

Whitaker, John T. Americas to the South. Demy 8vo. Pp. viii +300. (New York : The Macmillan Company, 1939.) 12*s.* 6*d.* net.

General Biology : Natural History Botany : Zoology

Adamstone, F. B. A Laboratory Manual of Vertebrate Embryology. Roy. 8vo. Pp. 87. (New York : John Wiley and Sons, Inc. ; London : Chapman and Hall, Ltd., 1940.) 7*s.* 6*d.* net.

de Beer, G. R. Embryos and Ancestors. (Monographs on Animal Biology.) Demy 8vo. Pp. x +108 +2 plates. (Oxford : Clarendon Press ; London : Oxford University Press, 1940.) 7*s.* 6*d.* net.*

Blyton, Enid. Birds of Our Gardens. Med. 8vo. Pp. 160. (London : George Newnes, Ltd., 1940.) 5*s.* net.

Burlingame, L. L. Heredity and Social Problems. (McGraw-Hill Publications in the Zoological Sciences.) Med. 8vo. Pp. xi +369. (New York and London : McGraw-Hill Book Co., Inc., 1940.) 23*s.*

Capek, Karel. I Had a Dog and a Cat. Translated by M. and R. Weatherall. Cr. 8vo. Pp. 160. (London : George Allen and Unwin, Ltd., 1940.) 3*s.* 6*d.* net.

Cockburn, Russell R. Mally : the Story of a Dog. Pott 4to. Pp. v +248 +4 plates. (Toronto : The Macmillan Co. of Canada, Ltd., 1939.) 10*s.* net.

Dyball, R. H. A Biology Course for Schools. Cr. 8vo. Pp. viii +296. (London, Glasgow and Bombay : Blackie and Son, Ltd., 1940.) 4*s.* 6*d.*

Hardie, R. P. Ferox and Char in the Lochs of Scotland. Cr. 8vo. Pp. xix +226. (Edinburgh and London : Oliver and Boyd, 1940.) 7*s.* 6*d.* net.*

Harvey, Kate. Essentials to the Study of Nature and Simple Biology. (Macmillan's Easy Study Series.) Ex. Cr. 8vo. Pp. viii +152. (London : Macmillan and Co., Ltd., 1940.) 1*s.* 9*d.*

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Geology

A Descriptive Petrography of the Igneous Rocks

Vol. I: Introduction, Textures, Classifications and Glossary. By Prof. Albert Johannsen. Second edition. Pp. xxiv+318. (Chicago: University of Chicago Press; London: Cambridge University Press, 1939.) 27*s*. net.

THE publication of Prof. Johannsen's four-volume "Petrography" was completed by the appearance of the last volume in 1938. Notices of the work have appeared in NATURE, **129**, 636 (1932); **132**, 691 (1933); and **142**, 495 (1938). The first volume, dealing mainly with the textures and classification of the igneous rocks, now appears in a second edition.

In his preface to this new edition, Johannsen quotes a statement made by Tom Barth in connexion with certain proposed modifications of rock classifications: "One should always be careful not to spoil a good idea by undue improvements". Apparently adopting this advice, Johannsen has made very few alterations in his revision. Apart from a few minor improvements of the text and additions to the biographies of prominent petrographers, he has been content to make only the following changes. The summary of Hodge's quantitative system of rock classification has been replaced by short accounts of Lacroix's (1933) and Tröger's (1935) systems. A few pages are added dealing with Niggli's (1931) modification of Johannsen's classification and with Andreatta's (1937) modification of Niggli's modification; these few pages are headed with a figure of what appears to be a monkey-wrench—a pleasant gibe which most readers will appreciate. A new appendix, giving the definitions of some 750 rocks described in the other three volumes of the work, has been added, but the other appendixes and tables remain exactly as in the 1931 edition. Teuscher's (1933) method of describing granularity is summarized, and Fersmann's (1928) views on the origin of graphic texture are briefly mentioned. With the exceptions noted, no reference to new work appearing since 1931 is made.

Das Relief der Erde

Versuch einer regionalen Morphologie der Erdoberfläche. Von Prof. Dr. Fritz Machatschek. Band 1. Pp. xi+545+10 plates. (Berlin: Gebrüder Borntraeger, 1938.) 36 gold marks.

NOTWITHSTANDING the title of his great work, "Das Antlitz der Erde", Suess really provided the classic account of the skeleton of the earth's crust. Machatschek proposes to describe the true face of the earth, and to discuss the geological factors that have controlled its development. The whole work will exhibit the relations between the single physiographical units of the earth's surface and the geological-tectonic raw material from which they have been derived. It will be a study in morphotectonics.

This first volume here noticed begins with a few pages of introductory matter, dealing mainly with the classification of the major divisions of the earth's surface. Then follows a treatment of the continental block of Europe and Asia, that is, the part of these continents lying north and west of the Alpide fold-zones. The units of the British Isles, Middle Europe, Fennoskandia, Russia, Siberia, Central and East Asia are dealt with in turn. As an example of Machatschek's method, we may take his account of Fennoskandia; brief summaries of the Pre-Cambrian and Caledonian history are followed by a detailed description of the glacial and post-glacial happenings, and this by a discussion of the topography special to the dozen separate districts into which he divides the region. The second part of the volume deals with the Alpide fold-belt in Europe and North Africa, and treats of the Mediterranean countries.

There are 141 text-figures, many being morphological maps, and ten excellent morphotectonic plates which cover most of the greater regions of Eurasia. The bibliography is selected. The book is good meat for geologists and for those geographers blessed with some geological knowledge.

Mathematical and Physical Sciences

The Cyclotron

By Dr. W. B. Mann. (Methuen's Monographs on Physical Subjects.) Pp. xi+92. (London: Methuen and Co., Ltd., 1940.) 3*s*. net.

THE cyclotron is essentially an instrument acting as a source of very high velocity nuclear particles—protons, deuterons, neutrons and alpha-particles—which have been used successfully by physicists in the further study of the constitution of matter by atomic bombardment. Although the fundamental principles of the method were known more than ten years ago, it is during the past few years that the problems involved in the design and construction of practical apparatus have been solved by the work of E. O. Lawrence at the University of California, Berkeley. The author of this little monograph, Dr. Mann, spent a period of two years in Prof. Lawrence's laboratory, and so has been able to describe the principles and some of the possibilities of the cyclotron, as the result of first-hand experience.

After an introductory chapter, a description is given of the phenomenon of magnetic resonance acceleration, upon which the operation of the cyclotron depends. Details of the design of the cyclotron vacuum chamber and the associated magnet are then given, followed by somewhat less satisfactory chapters on the radio-frequency supply, and the adjustments and electric and magnetic focusing arrangements involved. The final chapter, entitled "Applications of the Cyclotron", would appear to be unnecessarily detailed, and much of the material discussed is not concerned with the cyclotron as such but rather with atomic physics and chemistry. This account could have been made more interesting to the general scientific reader, for whom this series of monographs is intended, by confining the description to a few examples, treated more generally. A good bibliography is included at the end of the book.

Advanced Calculus

By Prof. Ivan S. Sokolnikoff. Pp. x+446. (New York and London: McGraw-Hill Book Co., Inc., 1939.) 26*s*.

THE preparation of a book on advanced calculus always entails some difficulty, for, on one hand, essential rigour must not, at this stage, be sacrificed, while, on the other, the course must be sufficiently concrete to appeal to the student and especially to the practical student. There is no doubt that interest in mathematics is often thwarted by a too rigorous presentation of analytical doctrine, and yet even practical students must assimilate an irreducible minimum of valid theory in order to make an intelligent use of mathematics. With these thoughts in mind, it is interesting to turn to Prof. Sokolnikoff's new volume. In the preface, the author admits that the subject is far from easy, but lays down the unalterable aphorism that the solving of problems "is essential to a mastery".

The ideas the basis of which lies in geometry are presented intuitively, whilst proofs of many academic theorems, like those on convergence of monotone sequences; those of Bolzano-Weierstrass, Darboux and a few others, have been wisely omitted, although references to other treatises, where proofs may be found, are given. One very commendable feature lies in the fact that the author has relegated no difficult or essential proof to the exercises provided for the student's practice.

The course embraces the usual topics dealt with in what is generally known as advanced calculus. It begins with limits and continuity; derivatives and differentials; then passes to a full consideration of integration—including definite, multiple and line integrals, and, after two chapters on series, improper integrals. Finally, Fourier series and a simplified formal treatment of some of the important problems arising from the theory of implicit functions are discussed.

The text is written with clarity and is well illustrated both by diagrams and exercises, worked and unworked.

Algebra for Science and Engineering Students

By E. H. Lockwood. Pp. ix+102. (Cambridge: At the University Press, 1940.) 6*s*.

THIS book has been specially prepared for secondary school pupils taking advanced courses in science and engineering. As the author points out, its essential feature is brevity, the aim being to present those parts of the so-called 'higher algebra' which are essential for sixth form pupils, on the science and engineering side, who do not offer mathematics as a main subject. The course begins with indices, logarithms and surds, then passes to variation; the theory of quadratic equations; factors and their development, including cyclic symmetry and partial fractions; permutations and combinations, leading to the binomial theorem for a positive integral index. The remaining part of the volume is devoted to the elements of simple probability, series and an introduction to statistics. A few practical applications of some of the principles explained in the text are given among the exercises provided for the student to solve.

The deliberate brevity of the treatment renders the text, particularly in the earlier chapters, almost a summary—and a good summary too—of the algebra needed for a sound training in what, a few years ago, would have been called the non-mathematical sciences, and, judging by the preface, the author has the biology student especially in mind, for he states: "Biology is becoming every day more mathematical." The treatment of the latter part on probability and statistics is much fuller and interesting, and should prove a welcome introduction to these subjects.

The book is certainly valuable for its purpose and is well illustrated both by line drawings and exercises to which answers are given. In the case, however, of engineering or physics, is not a full course in mathematics, taken to main subject standard, essential?

Electricity and Magnetism for Students

By S. R. Humby. Pp. 319. (London: John Murray, 1939.) 6*s*. 6*d*.

THIS excellent book is intended mainly for students who are preparing for entrance scholarships to the universities, and the Higher School Certificate and University Intermediate examinations, while it also covers a lot of the ground necessary for an ordinary degree. One of the many good features of the book is the flexibility of the treatment given, for as the author says in his preface, "Each chapter gives a complete, though necessarily limited, discussion of its part of the subject"; this means that the chapters may be dealt with in any order to suit requirements, and though in the book the work on electrostatics is separated from that on current electricity by the long chapter on magnetism, the author does not suggest that this sequence should be rigidly adhered to.

Mr. Humby has kept the needs of the students well in the forefront, and his courage in concentrating on one aspect of a theory which can be approached by several methods is to be commended, and will no doubt be greatly appreciated by students.

The author claims to have made a special effort to resolve the difficulties of magnetic induction, and it must be said that the skilful way in which he has developed this theory in the same chapter as other magnetic phenomena, instead of making it appear more formidable by devoting a separate chapter to it, seems to have justified his claim. Another pleasing feature is the logical sequence adopted in connexion with conduction of electricity, the conduction in solids, liquids and gases being dealt with in successive chapters.

Altogether it is an up-to-date book, well produced on very sound lines, and it should be found very helpful by students.

Household Physics

By Walter G. Whitman. Third edition. Pp. vii+436. (New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1939.) 18*s*. net.

THIS book, now in its third edition, deals with the practical applications of physics with particular reference to the home. The general plan of the first edition has been retained, but many changes have been made and six new chapters have been added, including one on air-conditioning.

Throughout the book the everyday experiences of students are used as a base from which to develop the concept of the fundamental laws of physics; there are twenty-eight chapters embracing examples in all the main branches of the subject, and since the whole is so comprehensively treated, the author has found it impossible to give great detail. Many very clear diagrams are included, and at the end of each chapter a useful summary of the main points is given, also a few suggestions for further study.

The book will provide interesting and instructive reading to both boys and girls, whether they are proceeding to a more academic treatment of the subject or not, and certainly a greater knowledge of the underlying principles and the operation of many devices found in the modern home will be of benefit to all. The student must be warned, however, that in some cases the author has been compelled, owing to lack of space, to give a necessarily condensed and incomplete theory; this is sufficient for ordinary purposes, but the student who is interested in pure physics will wish to go more deeply into such theory.

Miscellany

Acute Infectious Diseases

A Handbook for Practitioners and Students. By Dr. J. D. Rolleston and Dr. G. W. Ronaldson. Third edition, revised and enlarged. Pp. ix+477. (London: William Heinemann (Medical Books), Ltd., 1940.) 17*s*. 6*d*. net.

THE third edition of Rolleston's work, now under dual authorship, maintains the high standard of previous editions. The book is well produced, and, considering the amount of information supplied, is very convenient to handle. The absence of clinical illustrations, to which reference is made in the preface to the first edition, is amply compensated by the graphic description given of the cutaneous lesions of the acute exanthemata. It is unusual in a work of this size to find an attractive historical summary of each disease and also a serviceable bibliography. The source is a guarantee of scholarship and accuracy.

At a time when infectious diseases are specially liable to occur, the publication of such a book is opportune, for it offers to all, whether in the Services or in civilian practice, a reliable guide on all matters of treatment and prevention. Since the publication of the last edition, chemotherapy has revolutionized the treatment of certain infectious diseases, the use of serum in treatment and prevention has been extended, and much work has been done with regard to immunization, more especially in the virus diseases. All these subjects have received a detailed consideration which will be of value to the practitioner. Two additional chapters deal with erysipelas and isolation methods. The former is opportune as erysipelas is an excellent example of a disease amenable to both serum treatment and chemotherapy. The last chapter, with plans of modern isolation blocks, will appeal to all who are interested in administration.

The Annual Register

A Review of Public Events at Home and Abroad for the Year 1939. Edited by Dr. M. Epstein. Pp. xiv+507. (London, New York and Toronto: Longmans, Green and Co., Ltd., 1940.) 30*s*. net.

IT is seemly that an annual volume that now makes its hundred and eighty-first appearance should be published at the accustomed time and should maintain its normal size and all its normal features. As usual, more than half the volume is a review of world history with special regard to Great Britain and the British Empire. The year was one of preparation for war in most lands, but, as events have shown, a preparation that proved too leisurely even during the last four months of the year. Other European States receive full consideration, and the enigmatic attitude of the Soviet Union is revealing. The second part of the volume has the usual chronicle of events, obituaries and retrospect of art, science, literature and finance. The review of science directs attention to an unusually prolific year in biological publications and great advances in many aspects of that subject. Several important public documents are printed in full. They include the agreement with Poland, the treaty of mutual assistance between the United Kingdom, France and Turkey, the Russo-German pact and the various Soviet pacts with the Baltic States.

Philosophy

Causality and Science

By Prof. Nalini Kanta Brahma. Pp. 120. (London: George Allen and Unwin, Ltd., 1939.) 6*s*. net.

AS an ultimate assumption of science, the principle of causation is capable of a metaphysical analysis. Deploring the rejection of final causes by modern science, Prof. Brahma believes that the present interpretation of physics has not come to stay. For example, he questions that the indeterminism in the effect proves the indeterminism in the cause; and he contends that the idealistic view of physics is more superficial than fundamental. Moreover, scientific causality, whatever be its interpretation, is always partial, as it does not cover the other realm of values which give colour to life. The author rejects the mechanistic as well as the organic theory of causality. He holds that a cause is neither a sum total of conditions nor an implication of the whole effect latent in itself. For in both cases, causality lacks

purpose, intelligent direction and plan, the essentials of real creativity. In order to account for heterogeneous variations, it is necessary to assume an absolutely perfect cause; in essence, a creative will. This conclusion, which is in line with the Hindu notion of change as illusory, brings us into the field of metaphysics. But the discussion of the various conceptions of causality is a valuable addition to the critique of scientific method and of its implications.

T. G.

Charles Peirce's Empiricism

By Dr. Justus Buchler. (International Library of Psychology, Philosophy and Scientific Method.) Pp. xvii+275. (London: Kegan Paul and Co., Ltd., 1939.) 12*s*. 6*d*. net.

DR. BUCHLER'S clear presentation of Peirce's empiricism is extremely welcome. Peirce was a fertile and original thinker of no mean order; his work is too little known in Great Britain, but Dr. Buchler's book should introduce it to English readers. The task could not have been easy. Peirce was unsystematic in his thinking and fragmentary in his writings. Nevertheless, he is worth the labour of piecing together his disjointed reflections. His contributions to symbolic logic are of permanent value, and his conception of methods of inquiry and of establishing beliefs forestall much of the work that we associate with the names of Carnap and Wittgenstein. This is a book to be recommended.

Statistics

Statistical Mathematics

By Dr. A. C. Aitken. (University Mathematical Texts.) Pp. vii+153. (Edinburgh and London: Oliver and Boyd, 1939.) 4*s*. 6*d*. net.

THE recent appearance of several works on probability and statistics within a short time may suggest that they must overlap and that the subject is receiving undue attention. But on the contrary, while they are a sign of widespread interest, they differ sufficiently in aim and treatment to make them supplementary in a genuine sense. The subject can be approached from different points of view, and it has enough vitality to make the day far distant when a single text-book will be found satisfying.

This little book is so excellent and at the same time so inexpensive that it should be added to their collections by all who are interested in the methods of probability. It is a marvel of compression, but it must be understood that this result is due partly to a judicious choice of topics and partly to the consistent use of a general method. Its leading feature, in fact, is the introduction of the generating function in its several most important forms. By this means Dr. Aitken has succeeded in combining elegance and brevity without sacrifice of lucidity, though the less instructed reader may still find a more leisurely and pedestrian line of approach more congenial at an early stage. The book is naturally devoted mainly to the principles of statistics, but space is found for numerical examples fully worked and even for some explanation of modern statistical technique.

Statistical Methods

For Medical and Biological Students. By Prof. Gunnar Dahlberg. Pp. 232. (London: George Allen and Unwin, Ltd., 1940.) 10*s*. 6*d*. net.

G. DAHLBERG'S new book will be a disappointment to those who appreciated his excellent book on twins (1926). Its aim, to present statistical methods in a form calling for no special knowledge of mathematics, but at the same time to give some idea of the concepts on which these methods are based, is practically the same as D. Mainland's "The Treatment of Laboratory and Clinical Data"; but, whereas Mainland gives detailed explanations of the tests of significance most frequently used, even the *t* test finds no place in Dahlberg's book. It is puzzling that it should be published in 1940. R. A. F.

Tables of Random Sampling Numbers

By M. G. Kendall and B. Babington Smith. (Tracts for Computers, No. 24.) Pp. x+60. (Cambridge: At the University Press, 1939.) 3*s*. 9*d*.

AN early publication of the Department of Statistics, University College, was Tippett's series of random sampling numbers (1927), regarded by many at first as a most eccentric sort of publication. With the introduction of randomization as an experimental precaution, this table was soon found to save a great deal of time, and many laboratories provided themselves, for their own use, with additional random series. The recent "Tract for Computers" contains a hundred thousand new numbers.

R. A. F.

Tests of Significance

What they Mean and How to Use Them. By John H. Smith. Pp. ix+90. (Chicago: University of Chicago Press; London: Cambridge University Press, 1939.) 6*s*. net.

J. H. SMITH'S pamphlet is an indication that the teachers of business administration, like those of psychology and education, are becoming aware of the modern movements of statistical thought. The treatment seems clear and sound, and the ground covered is no more than that needed by all students of statistics. R. A. F.

A Bibliography of the Statistical and Other Writings of Karl Pearson

Compiled by G. M. Morant, with the assistance of B. L. Welch. (Issued by the *Biometrika* Office, University College, London.) Pp. viii+119. (Cambridge: At the University Press, 1939.)

MORANT'S bibliography of Karl Pearson covers 648 items from 1879 to 1935. Short annotations are given in some cases, but for the student of the history of statistics these are too colourless to be helpful. The work is an unsparing labour of love.

R. A. F.

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Glasgow, where he was trained as an anatomist by Prof. John Cleland, whose senior medallist and junior demonstrator he was. He graduated with honours M.B., Ch.B. in 1907 and was Brunton Memorialist of his year. After a year in private practice he became senior assistant to Prof. T. H. Bryce in his old University. In 1915 he received the Bellahouston and Struthers gold medals for his M.D. thesis on "The Scottish Skull", and was in the same year appointed by the Medical Research Council to work under the late Dr. John Brownlee on the stupendous task of compiling and analysing a case record and card-index of all officers and men admitted to hospital during the War of 1914–18. This work, which was not completed until 1922, involved the preparation and arrangement of 22 million index cards and the analysis of a million and a quarter medical case sheets. This material was taken over by the Ministry of Pensions.

Young continued on the staff of the Medical Research Council until 1927, when on the death of Dr. Brownlee and after taking the D.P.H. of Cambridge, he was transferred to the external staff and by a special arrangement was attached to Elliot Smith's department at University College, London, holding the position of lecturer in anatomy. This was perhaps the happiest and most fruitful period of his life. It gave him the opportunity he had long desired, to return to his studies in anatomy and anthropology, as well as of exercising his powers of statistical analysis, of which he had first given assured evidence in his thesis on the Scottish skulls, and had further demonstrated in statistical papers, some twenty in number, published during 1920–27 and including studies in epidemiology and the incidence and mortality of cancer. It has been said that Young's work substantially raised the standard of medical research in Great Britain by insisting on the proper biometrical treatment and interpretation of numerical data. Further, his work at University College in congenial surroundings gave full scope to those sound, if unobtrusive qualities, of which the most highly valued was his constant readiness to place his abilities and his profound knowledge at the service of colleagues and students alike. He was invited to join the committees of the Medical Research Council on dental disease and statistics. In connexion with the work of the former he published a study of the relation of dietary deficiency to dental disease, dealing with data collected in Birmingham under the auspices of the committees.

As anatomist and anthropologist, Young published numerous papers, perhaps half in collaboration with others; and it is no exaggeration to say that several of these of considerable value would never have been written had it not been for his encouragement and readily offered assistance. He was particularly interested in the problems of facial growth with reference to the development of dentition. One of his most important contributions to the subject was a study of the growth of face and jaws in children, which with other work gained him the D.Sc. of the University of Edinburgh. More directly anthropological studies were his collaboration with Sir Grafton Elliot Smith in the study of the London skull known as "The Lady of Lloyd's".

Mr. H. Higgs

HENRY HIGGS, who died on May 21, belonged to that type of economist of which John Stuart Mill was the leading example in an earlier generation, the economist public servant. Born in 1864, he entered the Post Office secretariat in 1884; was transferred to the Treasury fifteen years later; and served as private secretary to a succession of statesmen. He retired from the Treasury in 1921; was for a time lecturer in economics at Bangor and, for the ten years, 1929–39, was occupied mainly with work on the "Economic Bibliography", of which a first volume appeared in 1935.

While at the Treasury, Mr. Higgs was the first secretary of the Royal Economic Society and joint editor of the *Economic Journal* from 1892 until 1906. He had special knowledge of the thinkers of the eighteenth century; and his work on Cantillon and the Physiocrats was of a high order. His position at the Treasury enabled him to write with authority on questions of public finance. But, as his editing of Jevons's "Principles of Economics" (1905) and his repeated tenure of the Newmarch lectureship in statistics show, there was no aspect of economic thought with which he was not in contact.

Besides, Higgs had served as Inspector General of Finance in Egypt (1912–15) and had done other specialist work for the State. This made the range of his scholarship the more remarkable and explains the fact that, in spite of it, his learned output was rather fragmentary—the product of the hardly secured leisure of a very busy man. Some of the editorial work with which he was engaged after his retirement from public and academic activity was not of the kind to bring him much added reputation, and not all of it was equal to the work of his prime. In these last years he was, however, handicapped by failing health and almost complete deafness, which isolated him somewhat from colleagues and friends.

WE regret to announce the following deaths:

Prof. W. F. Bork, emeritus professor of psychology in Indiana University, on May 22, aged sixty-six years.

Prof. A. Fowler, C.B.E., F.R.S., emeritus professor of astrophysics in the Imperial College of Science and Technology and in the University of London, and formerly Yarrow research professor of the Royal Society, on June 24, aged seventy-two.

Dr. Phyllis Tookey Kerridge, formerly lecturer in physiology, University College, London, on June 22.

Dr. Alvin S. Wheeler, emeritus professor of organic chemistry in the University of North Carolina, on May 12, aged seventy-three.

Prof. F. J. E. Woodbridge, emeritus Johnsonian professor of philosophy in Columbia University, on June 1, aged seventy-three.

NEWS AND VIEWS

Salvage and Utilization of Waste

A LEADING article in this issue of NATURE (p. 988) is devoted to a discussion of certain aspects of the salvage and utilization of waste. It is interesting to note that the sixth report issued by the Select Committee on National Expenditure consists of the conclusions reached by a Sub-Committee on Supply Services which has investigated the relation between the work of the Ministry of Supply and the Office of Works. These two departments are responsible for the provision of stores of various kinds, and, working independently as they do, they tend to compete with each other, thus causing unnecessary confusion.

The report recommends the appointment of a national controller of salvage, who shall direct the work of an inter-departmental committee which shall supervise the salvage work of all departments. A more intense publicity campaign for the salvage of waste products is recommended, and, in particular, it is suggested that the virtues of refuse dust as a fertilizer be made more widely known with the help of the Ministry of Agriculture and the National Union of Farmers. There is urgent need, too, for closer co-operation between the Salvage Department and the County War Agricultural Committees. This is particularly necessary in the important matter of the disposal of kitchen waste suitable for the feeding of pigs. There is no questioning the need for the appointment of a national controller of salvage with full power of co-ordination. The sooner the appointment is made, the sooner will the nation be in a position to use its so-called waste products effectively.

The Linnean Society during War-time

AT the anniversary meeting of the Linnean Society held on May 24, the retiring president, Dr. J. Ramsbottom, delivered his presidential address, the substance of which appears elsewhere in this issue (p. 993). Discussing the affairs of the Society, Dr. Ramsbottom said it was decided that at the beginning of the War it was not only in the best interests of the Society but also of biological science that the Society should remain in Burlington House. No matter what happens it is hoped that the present policy shall continue. The Linnean collections, the Smithian collections and certain other irreplaceable belongings have been removed. Thus all reasonable precautions with the Linnean collections have been taken; but what if they should meet with disaster? During the time the collections have been away abundant evidence has been shown of the difficulties which arise when the Linnean Herbarium and the insect collection cannot be consulted. The Society has the negatives of photographs taken at various times of numerous specimens. Would it not be advisable to have photographs of the whole of the specimens taken under botanical or zoological supervision? Prints could be sold to anyone and complete sets might be kept in one or two places: or it may be that reproductions could be published. It would be advisable also to photograph all the types in the Smithian Herbarium. There would be no point in publishing these, but records that can be preserved in safety would be available. The problem of manuscripts should also be considered. Would it not be wise to have microfilms or photostats of the Linnean correspondence and all important unpublished manuscripts in the Society's possession? These again should be distributed.

Amateurs in Natural History

At the 150th anniversary meeting of the Society it was shown that it regards natural history societies as workers in the same field. Many prominent fellows of the Society are keenly interested in their local natural history societies. Dr. Ramsbottom thinks it would be well if the Society encouraged the idea that election to the Linnean Society of London should be the hall-mark of excellence in the study of natural history. If this were so the Society would continue to have that leaven of the amateur which is so necessary to the well-being of the Society. Amateurs were in the past the very backbone of British biology: it would be a sad blow to the democracy of science, even to science itself, if the Linnean Society were ever to be regarded as a domain reserved for the professional worker. "As a Society, then, our task during the War is to carry on as normally as possible, and to help others to do the same. In this connexion the Council has agreed to bring forward a motion, similar to one passed during the last War, that refugee biologists should be allowed certain privileges such as permission to attend meetings and to use the library".

H.M. Forces and Natural History

As individuals, fellows of the Society may have an opportunity of doing something, though not in a very spectacular way. There are many in H.M. Forces who might be helped over difficult periods if they became interested in natural history. Many of these men are seeing the common plants, birds and insects of the countryside for the first time, others in circumstances when their interest is easily aroused. Entertainment of the troops is usually of a certain type, excellent in its way, and nowadays the most popular of its kind. But some need more than mere amusement. It is not a matter of previous education but of temperament. The need may be met with music, or poetry, or other literature; for some it is in natural history. What can one say in answer to a letter asking whether the enclosed flower is a cowslip? It may be to settle a bet—but it at least shows an interest and it is up to us to encourage any such interest, not with the intention of popularizing our special subjects, or for any other purpose whatsoever

beyond helping these men to think of things other than evil ones. There is no need to organize such efforts. The more informal they are the better. Dr Ramsbottom suggests that any fellow who is prepared to help in this direction should get into touch with the Y.M.C.A. or similar organization at the nearest camp; or with the padres at the military hospitals. Here they will find a knowledge of individuals which is amazing, and an offer to talk to one or two men or to give a lecture on some aspect of biology which has a popular appeal will invariably be accepted.

Chair of Electrical Engineering, Birmingham

THE chair of electrical engineering in the University of Birmingham, vacated by the resignation of Prof. B. L. Goodlet, has been filled by the appointment of Dr. Cecil Dannatt. Dr. Dannatt has had many years experience with the Metropolitan-Vickers Electrical Co., Ltd., at Manchester, especially in the Research Department, where he has for some time been in charge of the Electrical and Magnetic Laboratory. His work has brought him into close contact with various branches of the industry and has given him opportunities of judging the needs and capabilities of young men in training for routine work and for research in electrical engineering. In the 1938–39 session, Dr. Dannatt was part-time lecturer in electrical engineering at Queen Mary College, University of London. Prof. Goodlet, who only took office in November last, resigned in order that he might make more effective use of his capacity in war-work elsewhere.

Books in War-time

IN NATURE of May 11, p. 719, we put forward the plea that books should not be subject to the proposed purchase tax. It has now been announced that on June 21 the Chancellor of the Exchequer received a deputation in this connexion composed of representatives of the church, literature, science, and education. The deputation consisted of the Archbishop of Canterbury (who introduced the deputation), Sir Arthur Eddington, Lord Hambleden, Mr. A. P. Herbert, M.P., Prof. A. V. Hill, Dr. Albert Mansbridge, Mr. J. B. Priestley, Sir Charles Grant Robertson, and Prof. R. H. Tawney. The Bishop of Chichester and Sir Will Spens were unavoidably prevented from attending. The deputation was accompanied by Mr. Geoffrey Faber and Mr. G. Wren Howard, president and vice-president of the Publishers' Association, and Mr. Stanley Unwin, chairman of the Books and Periodicals Committee of the British Council.

Pest Control Chemicals

AT a recent meeting of interested firms, the Pest Control Chemicals Export Group was formally inaugurated, with headquarters at 166 Piccadilly, London, W.1. The Group has now received the recognition of the Export Council of the Board of Trade. The broad object of the Group is to promote the export trade in such chemicals. Any British persons, firms or bodies corporate actively engaged in the manufacture and export of pest control chemical products, such as (*a*) disinfectants, (*b*) sheep and cattle dips, (*c*) agricultural insecticides and fungicides and (*d*) animal medicines and allied products are eligible for membership of the Group. The main Group comprises four autonomous sub-groups to deal with the problems arising from each of these sections of the industry. Thirty-six firms have already signified their intention of joining the Group. The first problems of the Group will be in connexion with materials in short supply.

Evulsion of Front Teeth in East Africa

IN reference to recent comment in NATURE (April 20, p. 631) on Dr. Aleš Hrdlička's study of the practice of removing the front teeth found among primitive peoples, Dr. Frank Marsh, c/o Anglo-Iranian Oil Co., Ltd., Pathological Laboratory, Abadan, Iran, suggests an alternative to the ritual origin of the custom, based upon his experience in British East Africa. There, he points out, the practice of removing the incisors is almost entirely confined to the Masai and related tribes. These tribes are warrior castes who under their natural (pre-controlled) condition lived by and for fighting; and in the course of this pursuit they expected to receive wounds, especially from arrows carrying poison derived from putrescent flesh. The juices of putrefaction contain large numbers of the spores of *Clostridium tetani*, causing lockjaw. The victim is then fed on milk and other liquids introduced through the toothless gap. Some recover—a result rare among civilized peoples. Dr. Marsh suggests that this may be a definite practical reason for the ritual removal of the teeth.

While it is unquestionable that practical experience of the kind to which Dr. Marsh refers would tend to perpetuate the practice in a given group of people, its influence probably is secondary. Various reasons are given by peoples who follow the practice; for example, it may be related to the escape of the soul from the body at death; while it is too widely distributed in time and space—it occurs among the mesolithic peoples of Palestine and North Africa—for it to be likely that a single practical purpose is implicated in all the varying conditions alike.

The Populations of Southern Algeria

DR. MAURICE GRONIER devotes his inaugural thesis (*Thèse de Paris*, No. 163; 1940) to the anthropological features and peculiarities of disease of the inhabitants of southern Algeria. The Arab population is characterized by a fairly high average stature, distinct dolichocephaly and leptorhinia, while the Mzabite population is distinguished by a higher stature, a relatively long trunk, a tendency to mesocephaly and a higher nasal index. The dentition of these populations is remarkably good, there being an exceedingly low percentage of caries. In addition to widespread malaria, parasitic invasion of the skin and alimentary canal and especially trachoma, the points in which the natives of southern Algeria show a striking contrast with Europeans are as follows:

the absence of the nervous complications of syphilis in spite of the prevalence of that disease, the low incidence of diseases of the liver, the rarity of appendicitis, the frequency of pain in the region of the solar plexus, the prevalence of the osteo-articular and glandular forms of tuberculosis and the frequency of cataract in elderly persons.

Euthanasia

IN the April issue of the *Quarterly Review*, Sir Arthur Hurst discusses the question of euthanasia from a practical point of view without any sentimental considerations. Those in favour of the practice, he points out, maintain that euthanasia should only be carried out on persons who are affected with an incurable and painful disease, which cannot be controlled by any form of treatment. On the other hand, the cases in which euthanasia appears most desirable do not come within the scope of the Euthanasia Act, which requires the expressed desire of the patient that his life should be ended. Such cases are those of new-born babies with severe deformities or conditions preventing normal mental development, or that of the intelligent man who becomes paralysed and is unable to communicate his wishes by speech or writing.

Sir Arthur condemns the unjustifiable confidence displayed by the advocates of euthanasia in the ability of two independent medical advisers, however experienced they may be, to decide whether a disease is incurable, and quotes several examples of patients condemned to death by eminent physicians or surgeons making an unexpected and complete recovery. In undoubted cases of incurable and painful disease, in which no relief can be obtained except by morphia, Sir Arthur recommends that the patient should be kept permanently free from pain by gradually increasing the dose and giving the injections as often as is necessary. Moreover, pain can be controlled not only by drugs but also by surgical operation, which is particularly indicated when the painful disease is not likely to be rapidly fatal and the administration of morphia is therefore undesirable.

Photo-cell Applications in the Foodstuffs Industries

IN commerce the difference between one quality of rice and another consists mainly in the proportion of discoloured grains present. Since hand-sorting has never been commercially practicable, the mechanical and electrical method of sifting out the discoloured grains by a machine, described in a paper by A. Seymour in the *Electrical Times* of June 6, may have far-reaching effects. The machine utilizes the properties of a photo-cell. By an ingenious mechanical method, the grains emerge from the feeder in a single line at a speed of 5 ft. per sec. and pass under the electric 'eye'. The perfect grains shoot straight forward into a tube leading downwards to a sack. Discoloured grains cause an electrical impulse through the photo-electric cell; this brings into action a jet of compressed air, which sends them into another receptacle.

Examination of granulated sugars is more elaborate, as it includes a classification of the finished sugars for general appearance and an evaluation of the colour and turbidity of the sugar solutions. Experiments with photo-electric apparatus have shown that good correlation exists between the appearance of a sample of granulated sugar and its reflectance relative to magnesium oxide. A specially designed optical system in the photo-electric apparatus permits measurements of the transmittancy of sugar solutions as well as of the reflectance of the sugar in granulated form. Numbers obtained from these data enable the expert to compare the relative merits of the samples.

The Edinburgh Botanic Garden

A PAPER by John M. Cowan (*J. Roy. Hort. Soc.*, **65**, Pt. 3; March 1940) describes the various botanical personalities who have contributed thought and organization to the development of the Royal Botanic Garden, Edinburgh. This is one of the oldest 'physic' gardens in Britain, and was established in 1670 by Robert Sibbald, with help from his friends Andrew Balfour and Patrick Murray. The first 'intendant' was James Sutherland, whose subsequent appointment as the first professor of botany at the University of Edinburgh ensured that close co-operation between academic plant science and practical horticulture which has been so marked a feature of the institution throughout its history. The Prestons, Charles Alston and John Hope succeeded Sutherland, each adding patiently a solid quota of work. Rutherford, discoverer of nitrogen, was also in charge of the garden, and more recently, J. Hutton Balfour and Sir Isaac Bayley Balfour have enhanced the reputation of the garden as an academic centre. It now possesses modern laboratories, and provides a stimulating part of the curriculum for students in medicine, arts, pure science, forestry and agriculture.

Road Obstruction Lanterns

THE General Electric Co., Ltd., has developed a road obstruction lantern which complies strictly with the Lighting (Restrictions) Order, 1940. The use of these electric lanterns for fixing to street bollards or other supports has many advantages. Not only does it mean a saving ranging from 2*d*. to 6*d*. per lamp per day, but it also saves in oil and man-power. According to *Roads and Road Construction* of June 1, in one London borough alone the saving effected in this way amounts to nearly £5,000 a year. The G.E.C. lantern is constructed of lead-coated sheet steel and has three sides, stencilled with the approved St. Andrew's Cross sign and backed with white opal glass. Inside are a detachable baffle and a B.C. lamp-holder for use with a 15-watt pearl Osram lamp. This provides the correct amount of light (0·5 candle per square foot) on the crosses. The lamp is easily accessible for wiring and maintenance. The lantern is supplied finished with either black or white outside. A two-lamp unit is preferred by some authorities because of the advantages of ensuring that there is a light on the island even if one lamp fails. The cost of the G.E.C. two-lamp lantern is little greater than that of the standard unit.

Earthquakes during May 1940

DURING May 1940, eighteen earthquakes were registered at the Swiss Seismological Observatories of Basle, Chur, Neuchâtel and Zurich. The observers at Zurich have estimated the epicentres of the larger shocks as follows: May 1, in the province of Parma in Italy; May 4, in the Pacific Ocean east of the Kamchatka Peninsula near lat. 50° N., long. 170° E.; May 7, in Anatolia near lat. 42° N., long. 34° E.; May 19, one again near the Kamchatka Peninsula about lat. 49° N., long. 158° E., and one possibly in the Indian Ocean; May 24, one near Lima in Peru, also one in Central Germany.

The United States Coast and Geodetic Survey, in co operation with Science Service and the Jesuit Seismological Association, has made a preliminary determination of the epicentres of the earthquakes of May 11 and 17. On twelve seismometric reports the epicentre of the shock of May 11 was calculated to be near lat. 53·2° N., long. 172·0° E., which is near the island of Attu at the extreme western end of the Aleutian Islands. On the basis of instrumental reports from Fordham, Ottawa, Weston, Pittsburg, St. Louis, San Juan, and Huancayo, the epicentre of the earthquake of May 17 turned out to be near lat. 7·9° N., long. 81·8° W., which is just in the Pacific Ocean off the coast of Panama to the south-west of Pueblo Nuevo. Most of these shocks were also recorded at Kew.

The Night Sky in July

ON July 1, the duration of night (sunset to sunrise) in the latitude of London is 7·5 hours; astronomical twilight (the sun not greater than 18° below the horizon) lasts all night until July 21. The moon is new on July 5 and full on July 19. The moon is in conjunction with Mars on July 6, with Jupiter and Saturn on July 28 and with Venus on July 31. From the western parts of North America, Venus will be seen to be occulted by the moon at this conjunction in daylight. There is no bright planet conspicuous now in the evening skies, since Mars—the remaining member of the notable group of bright planets seen in the evenings of the early part of this year—is getting too close to the sun for observation. At the beginning of the month, Jupiter and Saturn rise within a quarter of an hour of each other not long after midnight (U.T.). Venus is the bright morning star seen about one hour before sunrise in the middle of July and 2½ hours before sunrise at the end of the month. The planet is increasing in brightness towards its maximum on August 2. Close groupings of Jupiter's four inner satellites (to be seen with binoculars) occur about 2h. on July 2, 12, 20, and 21. The ring system of Saturn is well open, the minor axis of the outer ellipse of the outer ring being greater than 13″. The delta Aquarid meteors reach a maximum frequency about July 28.

Announcements

AT its meeting on June 21, the Council of the Lister Institute appointed Prof. C. R. Harington one of its representatives on the Governing Body of the Institute in succession to the late Sir Arthur Harden.

THE Royal Meteorological Society has awarded its Howard Prize (an aneroid barometer, given annually for the best essay on a selected meteorological subject) to Cadet S. R. Pryor of the S.A.T.S. *General Botha*. The subject of the essay was "The Relation of Wind to Ocean Currents".

AT the annual general meeting of the Royal Geographical Society, it was announced that the King, having approved the awards of the Founder's and Patron's Medal, had signified through the Keepers of the Privy Purse that the gold medals could not be struck until after the War. The complete list of the Society's awards was given in NATURE of April 27, p. 665.

THE annual general meeting of the British Social Hygiene Council will be held at British Medical Association House, Tavistock Square, W.C.1, at 4.30 p.m. on July 8. The president, Sir Walter Langdon-Brown, will deliver an address on the activities of the British Social Hygiene Council since the outbreak of war. Tickets of admission may be obtained on application to the Secretary, B.S.H.C., Tavistock House South, Tavistock Square, W.C.1.

DR. E. H. CLUVER, secretary for public health and chief health officer for the Union of South Africa, has been appointed director of the South African Institute for Medical Research in succession to the late Sir Spencer Lister.

THE Plunket Society or Royal Society of New Zealand for the Health of Women and Children is proposing to erect a monument to its founder, Sir Truby King, whose system of infant feeding largely contributed to making the infantile mortality in New Zealand the lowest in the world.

A GIFT of a thousand dollars has been made to the International Association for the Prophylaxis of Blindness to promote research in ophthalmology. The subject chosen for a prize, which will be awarded on the occasion of the tenth International Congress of Ophthalmology, is simple non-inflammatory glaucoma. The address of the Association is 66 Boulevard Saint-Germain, Paris.

A PROGRAMME of some thirty papers on the applications of spectroscopy to problems of biology, chemistry, geology, metallurgy, medicine, physics, and various industries, has been arranged for the eighth summer conference on spectroscopy and its applications, to be held in the George Eastman Laboratories of the Massachusetts Institute of Technology during July 15–17. Further information can be obtained from Prof. George R. Harrison, Department of Physics, Massachusetts Institute of Technology, Cambridge, Massachusetts.

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. They cannot undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of NATURE. *No notice is taken of anonymous communications.*

IN THE PRESENT CIRCUMSTANCES, PROOFS OF "LETTERS" WILL NOT BE SUBMITTED TO CORRESPONDENTS OUTSIDE GREAT BRITAIN.

NOTES ON POINTS IN SOME OF THIS WEEK'S LETTERS APPEAR ON P. 1024.

First Use of Current-Bedding to Determine Orientation of Strata

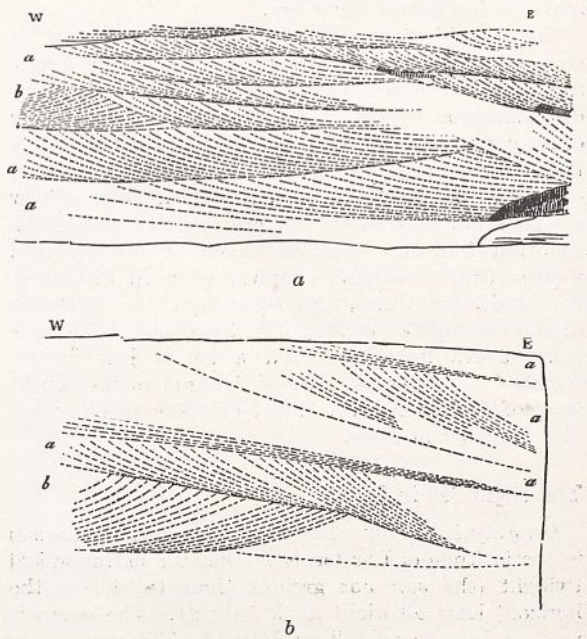
DR. ROBERT M. SHACKLETON[1] has recently completed a revision of the structures of the Silurian and Devonian rocks of the Dingle Peninsula and Blasket Islands in south-west Eire. In this he has used the positions of truncated tops and asymptotic bases of current-deposited laminæ in order to determine the correct order of succession, and has been able to demonstrate the probable equivalence of Anascaul Beds with Ferriter's Cove and Croaghmartin Beds (Silurian) and of Smerwick Beds with Dingle Beds (Downtonian). Axes of folding that trend from east-north-east to west-south-west have been plotted, and inverted beds are conclusively recognized on the north and south margins of the Peninsula and at Clogher Head. The final proof that the axis of an overfolded syncline runs through Ventry Harbour, Fahan Point, and between the Great Blasket and the two smaller islands of Inishnabro and Inishvickillane, vindicates the work of G. V. Du Noyer prior to 1859 in first tracing the inversion south of this important line and describing it despite opposition by J. Beete Jukes[2], director of the Irish Geological Survey.

It is also of interest from the historical point of view to recall that it was from the Dingle Beds, at Slea Head, facing the Great Blasket, so early as 1864, that figures of false-bedding, used to decide which way up strata were lying, were published by John Kelly[3]. He concluded from the diagrams reproduced in the accompanying figure that at Slea Head the beds had their original tops orientated upwards, and showed that successive sets of laminæ were deposited by currents flowing at different times from approximately opposite directions. Kelly's conclusions have now been fully supported, so that it may be opportune to quote part of his pioneer description:

"In the laminæ of that part of the bed marked *a*, the thick end of every minor layer is uppermost, the fine point at the bottom and the curve downwards. In this case the view at Slea Head is taken so that the observer is looking towards the north, and it is evident that the current which brought the grains of sand to form the groups of laminæ *a*, *a*, *a*, came from the west; the current that brought and deposited the group *b* came from the east. . . .

". . . another sketch taken on the south coast of Slea Head, at Reenrooig . . . is of similar character . . . but in this case nearly all the sediment was brought from the west, only one group appearing to have come from the east. . . .

"This fact of the thick end of the laminæ of deposition being up and up stream, and the point downwards and down stream . . . is important, inasmuch as from it we may know . . . what side of a bed was uppermost when it was deposited, and thus



SCALE: THREE FEET TO ONE INCH.

CURRENT-BEDDING IN COARSE BROWN GRITS (DINGLE BEDS) SHOWING STRATA RIGHT WAY UP AT REENROOIG (*a*) AND LACKLETTERA (*b*), NEAR SLEA HEAD, DINGLE PENINSULA. (AFTER JOHN KELLY, 1864)

in the Silurian and Devonian beds of the south of Ireland, it may be known where steep dips or complex contortions present themselves, whether the original upper side of a bed is still uppermost, or whether a group of beds has been overthrown and turned upside down, as is sometimes the case.

"These facts were noticed by Mr. Patrick Ganly, who made numerous drawings of this kind of lamination about Slea Head for Sir Richard Griffith."

John Kelly goes on to describe the relation between ripple-marks and false-bedding. His account is a matured one, so that probably the results date from some years earlier than the time of publication in 1864. The author seems to be the same person as the J. Kelly engaged as an assistant geologist along with Du Noyer in the survey of Dingle. There is, therefore, little doubt that these remarkably modern views were known in Ireland when the Survey Memoir of 1863 appeared. In them we may have the clue to Du Noyer's positiveness about the inversion of certain beds, now justified by Dr. Shackleton[4]. But there is nothing of this evidence in the memoir, in which references to current-bedding are cursory. The cause of the suppression may with some certainty

be found in differences of temperament that existed between Jukes and his junior officers.

It would be satisfying to know whether any of Patrick Ganly's drawings survive. More information about that observer and about his possible contact with Du Noyer would be most welcome. Probably contemporary letters still exist which contain information regarding the respective parts played by these Irish geologists in interpreting current-bedding and in applying the results to determine tectonic positions of strata. Du Noyer died young, and to him, as artist and as maker and interpreter of geological maps, it seems that justice remains to be done. His field-maps, so numerous and so careful, preserved in the offices of the Geological Survey of Eire, have a beauty of their own that can only be compared with the subsequent achievement of Lapworth.

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May 7.

[1] Shackleton, R. M., "The Succession of Rocks in the Dingle Peninsula, Co. Kerry", *Proc. Roy. Irish Acad.*, B, **46**, 1–12, 4 figs., pls. I–III (1940).

[2] Jukes, J. B., and Du Noyer, G. V., "Explanation of Sheets 160, 161, 171 and Part of 172 . . . Illustrating Part of the County of Kerry", *Mem. Geol. Surv. Ireland*, p. 25 (1863).

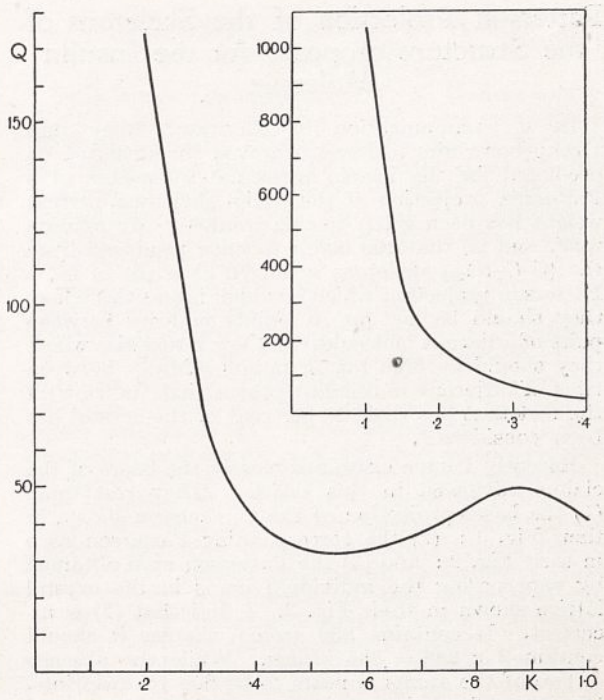
[3] Kelly, John, "Notes upon the Errors of Geology Illustrated by Reference to Facts Observed in Ireland", pp. 156–158, 161–163, figs. 1–2, plate 9 (1864) (London: Longmans, Green, Longmans, Roberts and Green).

[4] *Op. cit.*, pp. 6–7.

Cross-section of Atomic Oxygen for Elastic Collision with Electrons, and Region *F* Absorption

IT is now generally agreed that the higher regions of the atmosphere—beyond 150 km.—consist predominantly of atomic oxygen. The absorption of radio waves in Region *F* of the ionosphere which lies above this level is thus caused by collision of electrons with neutral oxygen atoms. If one wants to estimate theoretically the frequency of such collision, a knowledge of the cross-section for elastic collision of atomic oxygen becomes necessary; we have therefore thought it desirable to calculate it by quantum mechanics methods for various electron energies up to 13 volts. The method employed for numerical solution is that developed by Hartree[1] for the determination of self-consistent fields. The results obtained are shown in the accompanying curves. The collisional cross-section is seen to increase rapidly in a manner not observed for the cases of N_2 and O_2.[2] The fact that atomic oxygen exhibits the Ramsauer effect, as seen from the figure, is of importance in the interpretation of absorption processes occurring in Region *F*.

The curve may be utilized for calculating the collisional frequency in Region *F*. If the temperature of the region be taken as 1,000° K., after Martyn and Pulley[3], and density of oxygen as 4×10^9 atoms per c.c., after Mitra and Rakshit[4], then the collisional frequency calculated by using the appropriate cross-section obtained from the curve is found to be $2{\cdot}4 \times 10^3$/sec. This agrees with the value 2×10^3/sec., which is the mean of the values obtained by various workers from radio measurements[5]. It should be pointed out that even a large change in the assumed value of temperature of the electrons does not produce any marked change in the calculated value of the collisional frequency. This is because an increase in collisional frequency due to the increased average velocity is roughly balanced (as may be seen from the curves) by the decreased cross-section. It may be noted that the collisional frequency calculated by taking the gas kinetic cross-sections yields a value of only 70 per sec., which shows that for such slow collisions as occur in the ionosphere, one must use the quantum mechanics calculated cross-section and not the gas kinetic cross-section.



Q, CROSS-SECTION OF O I FOR ELASTIC COLLISION WITH ELECTRONS.

$$K, \sqrt{\frac{\text{ELECTRON VOLT}}{13{\cdot}53}}$$

It is, however, interesting to note that for Region *E* the collisional frequency calculated by taking the gas kinetic cross-sections of N_2 and O_2 (predominant gases in Region *E*) agrees with the result obtained by radio method. This, as has been pointed out[6], is due to the fact that the values of gas kinetic cross-sections of N_2 and O_2 accidentally agree with those computed by quantum mechanics for the range of electron energy considered.

A fuller and more detailed account will shortly be published in the *Indian Journal of Physics*.

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[1] Hartree, *Proc. Camb. Phil. Soc.*, **24**, 89 (1928).

[2] Fisk, *Phys. Rev.*, **49**, 167 (1936).

[3] Martyn and Pulley, *Proc. Roy. Soc.*, A, **154**, 455 (1936).

[4] Mitra and Rakshit, *Ind. J. Phys.*, **12**, 47 (1938).

[5] Farmer and Ratcliffe, *Proc. Roy. Soc.*, A, **151**, 370 (1935). Bailey and Martyn, *Wir. Eng. and Expt. Wir.*, **12**, 122 (1935). Eckersley, NATURE, **135**, 435 (1935).

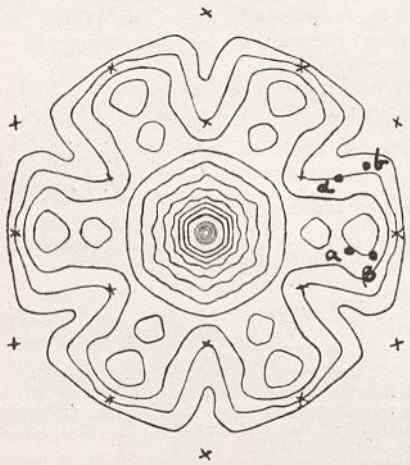
[6] Ray, *Science and Culture*, **3**, 679 (1938).

Patterson Projection of the Skeletons of the Structure proposed for the Insulin Molecule

IN a communication in NATURE[1], Riley and Fankuchen claim to have disproved the structure C_2 predicted for the insulin molecule[2] by means of a Patterson projection of the cyclol skeletons. Great weight has been given to this result[3,4]. My opinion was[5], and is, that the claim to have produced from the $(C–C–N)_{288}$ skeletons arranged at a tilt of 6°, a Patterson projection which has high intensities where they should be low (at A, points midway between pairs of adjacent molecules) and low intensities where they should be high (at B, points midway between trios of adjacent molecules) proves little in view of the fact that less than 27 per cent of the crystal has been considered[6].

Recently I have examined closely the bases of the claims advanced in this article. They rest upon (1) the basal projection of the C_2 skeleton shown in their Fig. 1; (2) the corresponding Patterson map in their Fig. 2; and (3) the Patterson map obtained by superposing the individual maps in the crystal lattice shown in their Fig. 3. I find that (1) is incorrect. It contains 850 atoms whereas it should contain $3 \times 288 = 864$ atoms. While the absence of two of the atoms appears to be due to misprints, the other 12 missing atoms seem to have been overlooked. Further, since it is claimed that "those parts of the cyclol molecule which have definitely and precisely been worked out by Wrinch" have been taken into account, it is necessary to point out that all the 288 C_β atoms and the skeletal oxygens have been omitted from consideration. (2) The tilt of the molecules is not defined by the crystallographical data. It is, however, obvious from Riley and Fankuchen's Fig. 2 that a small tilt (say, 0–10°) gives low A intensities and high B intensities, whereas a large tilt (say, 30–40°) gives low B intensities and high A intensities. The former is the situation found by Crowfoot[7] in her projection calculated from X-ray intensities, and a small tilt of about 6° (see NATURE, **142**, 582, Fig. 2) has been suggested by Wrinch[8] and by Wrinch and Langmuir[9] on the basis of the strong $(8, \bar{7}, \bar{1}, 0)$ reflection and for a number of other reasons.

To make the situation as precise as the rough sketch map allows, there is reproduced herewith Riley and Fankuchen's Fig. 2, to which have been added the points a and b and the points α and β which represent, when the tilt is 36° and 6°, one half and one third, respectively, of the intensities at A and B. The sketch map is unsupported by the numerical values calculated, but numbering the contours 0, 1, 2 . . . inwards, it appears that (roughly) $a = 2{\cdot}75$, $b = 0{\cdot}75$, $\alpha = 1$ and $\beta = 3$, giving $A = 5{\cdot}5$ and $B = 1{\cdot}5$ for a tilt of 36°, and $A = 2$, $B = 9$ for a tilt of 6°. Although it is stated by Riley and Fankuchen that a tilt of 6° has been chosen, an examination of their Fig. 3 shows that a tilt of 36° has been chosen, giving of course high intensities at A and low intensities at B.



On the basis of the facts here pointed out, all the claims of these authors fall to the ground and their laborious calculations (assuming that the omitted atoms do not seriously affect their Patterson map) appear to show that the contrary of what they say is true. With a tilt of 6°, they appear to have proved that the Patterson map of the C_2 skeletons gives low intensities at A and high intensities at B, in accordance with the findings of Crowfoot.

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[1] NATURE, **143**, 648 (1939).
[2] Wrinch, *Science*, **85**, 566 (1937); *Trans. Faraday Soc.*, **33**, 1368 (1937).
[3] Bernal, meeting of the Physical Society, Dec. 20, 1939.
[4] Bernal, Fankuchen and Riley, NATURE, **143**, 897 (1939).
[5] Wrinch, NATURE, **143**, 763 (1939).
[6] Neville, NATURE, **143**, 803 (1939).
[7] Crowfoot, *Proc. Roy. Soc.*, A, **164**, 580 (1938).
[8] *J. Amer. Chem. Soc.*, **60**, 2005 (1938).
[9] *J. Amer. Chem. Soc.*, **60**, 2247 (1938); *Proc. Phys. Soc.*, **51**, 613 (1939).

Depth of Focus of Microscope Objectives

IT is usually assumed that the depth of focus, t, of a well-corrected microscope objective is given by one or other of the following formulæ:

$$(A) \quad t = \frac{\lambda\sqrt{N^2 - (\text{N.A.})^2}}{(\text{N.A.})^2}$$ (Hardy and Perrin: "Principles of Optics", p. 511.)

or

$$(B) \quad = \frac{\lambda}{4N\sin^2\left(\frac{1}{2}\sin^{-1}\frac{\text{N.A.}}{N}\right)}$$ (Conrady: "Dictionary of Applied Physics", vol. 4, p. 222).

where N is the refractive index of the medium through which the light travels, λ the wave-length of the light used, and N.A. the numerical aperture of the objective.

These formulæ lead to the following depths of focus for the objectives given, in light of wave-length 5000A.

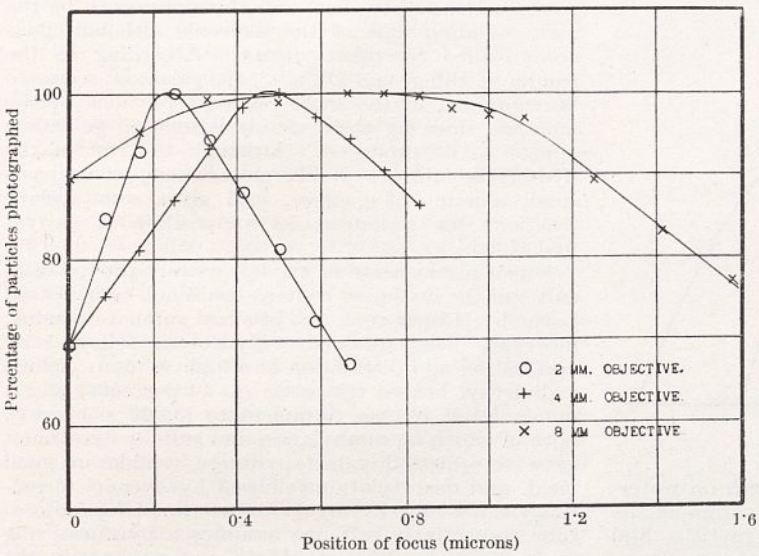
Objective	N.A.	Depth of focus (microns) Formula A.	Formula B.
2 mm. oil immersion ..	1·30	0·22	0·33
4 mm. dry	0·95	0·18	0·36
8 mm. dry	0·65	0·90	1·05

Graton and Dane[1] have, however, pointed out that the depth of focus appears to be much less than is expected theoretically, and I have recently made some investigations on the subject.

Very fine dust particles, mounted dry and ranging down to a size known to be smaller than 1/10 micron, have been photographed in blue-green light by methods described elsewhere[2] using Beck apochromatic objectives of the above types. By counting the numbers of particles photographed on plates taken at foci varying by about 1/12 micron, some estimate of the depth of focus of the objectives can

be obtained. The results, after correction for curvature of field present in the photographs, are plotted in the accompanying graph. It must be noted that the different objectives photograph down to different sizes of particles, and this factor makes it impossible to compare the curves with each other.

It will be seen from the graph that with both the 2 mm. and 4 mm. objectives, when the focus is out on either side of the best focus by more than about 0·1 micron, the number of particles photographed is significantly less than the maximum number photographed. The finest particles photographed at the best focus have a thickness which is not known exactly but which is believed to be of the order of 0·06 and 0·09 microns for the two objectives respectively; this amount must be subtracted from the apparent depth of focus. It seems certain, therefore, that both these objectives have a depth of focus of less than 0·15 micron, and the depth of focus may actually be very much less. This could be determined more accurately by using a still finer adjustment, but, at present, time does not permit of this investigation.



With the 8-mm. objective a certain portion of the curve is flat, but the flatness does not extend over a range of more than 0·70 microns; as the thickness of particle photographed with this objective is probably of the order of 0·14 microns, it seems that the depth of focus of this objective is certainly less than 0·55 microns and may be about 0·40 microns.

Naturally these depths of focus are increased by the adaptability of the eye when the objective is used visually.

It is obvious from these results that the present formulæ for the depths of focus of microscope objectives give values which are considerably higher than those found experimentally.

This letter is published by kind permission of the Gold Producers Committee of the Chamber of Mines.

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[1] *J. Opt. Soc. America*, **27**, No. 11 (Nov. 1937).
[2] Beadle, *J. Sci. Inst.*, **16**, No. 8, 262.

Diffraction Maxima in X-Ray Photographs

IN a recent communication[1] C. V. Raman and P. Nilakantan report the presence in Laue photographs of weak intensity maxima which cannot be interpreted as Laue spots. They suggest that the new maxima are due to lattice vibrations which cause stratifications of density with the same spacing as the lattice planes, but with an orientation variable between wide limits.

The effect observed by these investigators is not new. Such weak spots are commonly found in Laue photographs taken with an X-ray beam containing characteristic as well as continuous radiation. If the incident beam does not contain appreciable amounts of characteristic X-rays, radial streaks rather than spots appear in the Laue photographs. Earlier investigators have directed attention to these streaks or spots[2], and G. D. Preston (l.c.) demonstrated that the intensity of the spots increased with the temperature. Moreover, I presented a detailed theory of the effect before the American Physical Society at its meeting on December 1, 1939. An abstract of this paper was published in November last in the *Bulletin of the American Physical Society* and afterwards in the *Physical Review*[3].

According to this theory, the lattice vibrations cause diffuse scattering of X-rays showing a rapid intensity variation with the scattering direction. The intensity maxima are to be found in the directions u_m given by the equation $(1 + \lambda\tau)u_m = u_0 + \lambda B_H$, where u_0 is the direction of incidence, λ the wave-length of the X-rays, B_H a reciprocal lattice vector and τ the wave vector associated with a mode of vibration of the lattice.

The assumption of Raman and Nilakantan that the new maxima are due to lattice vibrations is thus confirmed. It should be pointed out that the positions of the maxima are not given by the Bragg law as Raman and Nilakantan seem to suggest. In the Laue photograph of diamond reproduced in their communication, the auxiliary maxima appear at a scattering angle of 43° 0′ ± 25′, as compared to 43° 16′ deduced from the equation given above and 43° 58′ from the Bragg equation.

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May 31.

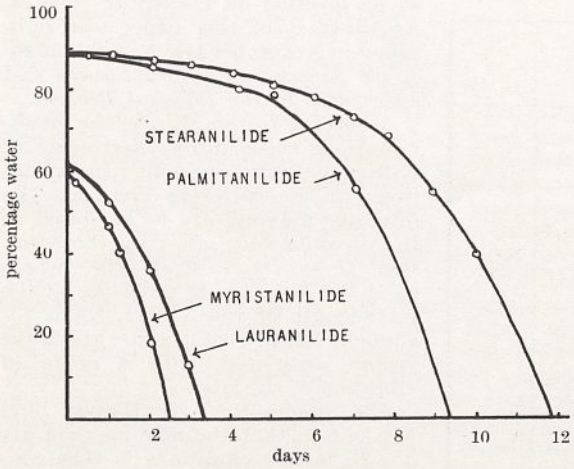
[1] NATURE, **145**, 667 (1940).
[2] See for example, Friedrich W., *Phys. Z.*, **14**, 1082 (1913). Preston. G. D., *Proc. Roy. Soc.*, A, **172**, 116 (1939).
[3] For detailed accounts see Zachariasen, W. H., *Phys. Rev.*, **57**, 597 (1940); Siegel, S., and Zachariasen, W. H., *Phys. Rev.*, **57** 795 (1940).

Hydration of Anilides of Normal Fatty Acids

I HAVE previously described the formation of hydrated stearanilide[1]. An investigation of some of the factors influencing the binding of water by substituted amides of the normal fatty acids is now in

progress. Since experiments of an exploratory character had shown that both the amount of water taken up and the tenacity with which it is held vary with the mode of hydration, a standard procedure for the production and examination of the hydrated compounds has been adopted.

5 gm. of the pure anhydrous amide is dissolved in 50 c.c. hot absolute alcohol and the solution rapidly stirred into 1 litre of cold distilled water. The hydrated amide, precipitated as a bulky white mass, is allowed to float in the water for 20 hours. It is then filtered off at the pump, drained by suction, spread out on a porous plate and dried over fused calcium chloride for 24 hours at atmospheric pressure. Samples (5–10 gm. each) of the material are examined by heating to constant weight in an oven (the oven temperature being about 10° below the melting point of the anhydrous amide) and by drying in open Petri dishes over fused calcium chloride both at ordinary pressure and *in vacuo*. In this way the total water content of the material is determined and an assessment of the tenacity with which it is bound can be attempted.



As a start, the influence of chain-length on water-binding capacity has been studied by examining the hydrated anilides of stearic, palmitic, myristic and lauric acids. In the accompanying figure are shown the percentages of water in samples of the hydrated compounds at intervals during drying over fused calcium chloride at ordinary pressure. It would seem that the ability to 'bind' water is possessed only by stearanilide and palmitanilide, for although both myristanilide and lauranilide take up considerable amounts of water, neither is able to hold it firmly enough to resist ordinary desiccation.

At this stage it seems not unreasonable to suggest that the water of hydration is held in the interstices of a micellar structure. Points in support of this view may be summarized thus: (1) the large amount of water bound, (2) both the anhydrous and hydrated anilides are hydrophobic, (3) heating the hydrated compounds to within about 5° of the melting point of the anhydrous amide results in the setting free, in liquid form, of all the bound water[1].

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[1] NATURE, **145**, 227 (1940).

Carrageen Mucilage

FOR some time we have been studying the mucilaginous polysaccharides of carrageen moss, and it now seems desirable, in view of the recent letter by Dillon and O'Colla[1], to communicate some of our results.

Preliminary experiments on the composition of the polysaccharide (hot extract) obtained by extraction with hot water as described by Haas[2] has confirmed his view that this was essentially the calcium salt of a carbohydrate ethereal sulphate, analysis of the ash (19 per cent) giving Ca, 5·6 per cent, SO_4, 12·5 per cent calculated on the original hot extract, total SO_4, 24 per cent.

Acetylation with pyridine and acetic anhydride under various conditions and for long periods was completely unsuccessful both on the hot extract and other carrageen extracts. It is significant that the acetolysis method of Dillon and O'Colla[1] caused extensive degradation, not only removing the ethereal sulphate residues but also the non-galactosic components.

Hydrolysis yielded a mixture of sugars containing galactose (*c.* 50 per cent) and this appears to be the main building unit of the molecule although it is accompanied by other sugars. According to the results of Dillon and O'Colla[1], the galactose seems to be contained in the most resistant portions of the molecule since by their acetolysis method galactans appear to be produced. Although the rest of the hydrolysis mixture yields glucosazone, contains a small amount of pentose, and gives some colour reactions for a ketose, its composition is as yet undecided.

Direct methylation of the hot extract proved difficult and the methoxyl content could not be increased beyond *c.* 15 per cent, the ethereal sulphate residue, however, being retained. Hydrolysis followed by acetylation and distillation in a high vacuum yielded a dimethyl hexose triacetate (*c.* 40 per cent) and a monomethyl hexose tetra-acetate (*c.* 20 per cent), both of which on methylation and suitable treatment gave tetramethyl galactopyranose anilide in good yield, and deacetylation followed by osazone formation yielded 6-methyl *d*-galactosazone and *d*-galactosazone respectively. If one assumes a pyranose ring to be present, although this is not necessarily the case, and takes into consideration that the polysaccharide is non-reducing and that therefore C_1 is involved in the linkage between adjacent units, it appears that in some units at any rate the second 'polysaccharide link' is on either C_3 or C_4 with the ethereal sulphate residue in the vacant position. It is clear, both from the methoxyl content of the methylated polysaccharide and from the isolation of 2-methyl galactose derivatives, that unless one hydroxyl group—probably on C_6—is occupied in some units by a residue resistant to methylation, there must be some shielding effect, possibly due to the sulphate residue, and this may also explain the difficulties of acetylation. The presence of two ethereal sulphate groups on one anhydro-galactose residue must be excluded, for this would require a much higher sulphate content than is observed. Finally, since the hot extract is essentially a calcium salt, adjoining chains of carbohydrate residues must be joined together by the divalent element, and this may have some bearing on the highly viscous solutions which are obtained and the difficulties of acetylation and methylation.

Further work is in progress on the non-galactosic portion and also on the polysaccharides extracted by cold water.

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[1] Dillon and O'Colla, NATURE, **145**, 749 (1940).
[2] Haas, *Biochem. J.*, **15**, 469 (1921).

Native State of Proteins in Egg-White

THERE are two opposing conceptions of the native state of proteins in biological fluids. One holds that the native particle is a complex of the various species of proteins present and is altered in the process of isolation. The other supports the independent existence of these species in a state of homogeneous dispersion. Difficulties of separation and inconstancy in amino-acid analyses support the former, and these were encountered[1] in efforts to separate and characterize the proteins in hen's egg-white. Block[2] has suggested the existence of an 'orosin' in egg-white on the basis of the ratio of arginine, histidine and lysine. The evidence from physical methods with blood serum supports the second hypothesis, but these have not been applied to egg-white except for a brief note by Svedberg[3] relative to irregularities in the sedimentation constant of native and 'purified' ovalbumin.

Egg-white has been examined in the ultra-centrifuge at 60,000 ($\pm$ 300) r.p.m. in a field strength of 270,000 times gravity using the 'diagonal schlieren' method of Philpot[4] in the optical system and a high-pressure mercury vapour lamp. The temperature of the rotor was 25–27° and the period of spinning up to five hours. Native egg-white and that diluted with 1 per cent sodium chloride from one to three times exhibited a single sedimenting boundary. The concentration of total protein varied from 9·8 to 2·6 per cent, measured by the Zeiss dipping refractometer and light of wave-length 546 mμ.

The differentiation of the native proteins in the white was attempted on the basis of ionic mobilities by the method of Tiselius[5]. The migration of the boundaries was followed optically by the 'schlieren' method using a sodium vapour lamp. The native or diluted egg-white was dialysed previously at 2° against a phosphate buffer mixture of *p*H 7·2 and 0·1 μ ionic strength until equilibrium was attained and chloride removed. Egg-white diluted three times, twice and once with buffer solution and exhibiting concentrations of total protein of 1·95, 2·75 and 4·00 per cent, separated into five and sometimes six boundaries. The electrophoresis was continued for three hours at a potential gradient of 120 v. and 10 mA. and a temperature of 1° C. In the most concentrated preparation three of the bands were heavy and three relatively light. A fresh preparation, with a protein concentration of 5·57 per cent, made with a phosphate buffer of *p*H 8·0 and 0·1 μ ionic strength gave a similar result in five hours of migration. The concentration of the original egg-white was 9·77 per cent. It has not been possible to study the migration of the native white without some degree of dilution by phosphate buffer. However, this is in remarkable agreement with the conclusion of five distinct protein components reached by Hektoen and Cole[6] on the basis of immunological reactions. The chemical methods of separation would, therefore, seem to have a degree of justification.

The chemical individuality of the products thus separated was tested. Using methods previously described[1], ovomucin and ovomucoid were very carefully fractionated and obtained in solution after dialysis against phosphate buffer of *p*H 7·2. Such solutions were never homogeneous. The best preparation of ovomucin showed a single boundary by electrophoresis but two by centrifugation in a concentration of 1·33 per cent. A specially purified preparation of ovomucoid showed three migrating boundaries in the Tiselius apparatus at 2·7 per cent concentration but only one sedimenting boundary in the centrifuge. The results thus appear to justify the further conclusion that our chemical methods are not yet adequate for the separation of the five or six species of protein in native egg-white.

The present note is published at this time because no further work appears possible in the immediate future. I wish to acknowledge the kind hospitality of Sir John Ledingham and Dr. A. S. McFarlane at the Lister Institute during the summer months of 1938, and the sympathetic assistance of Mr. R. A. Kekwick.

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April 22.

[1] Young, *J. Biol. Chem.*, **120**, 1 (1937).
[2] Block, *J. Biol. Chem.*, **105**, 455 (1934).
[3] Svedberg, NATURE, **128**, 999 (1931).
[4] Philpot, NATURE, **141**, 283 (1938).
[5] Tiselius, *Trans. Faraday Soc.*, **33**, 524 (1937).
[6] Hektoen and Cole, *J. Infec. Dis.*, **42**, 1 (1928).

Chemistry of Urea Stibamine

IN his article on the "Antimony Treatment of Kala-azar"[1], Sir Leonard Rogers referred to the findings of an early worker on the constitution of urea stibamine; reference was not made to later work on this subject, notably that of Gray *et al.*[2].

To some extent the controversy about the constitution of urea stibamine is comparable to that about atoxyl when it was discovered by Ehrlich. Gray *et al.* have noted that the most interesting of the more important derivatives of *p*-amino-phenyl stibinic acid is a material prepared by Brahmachari (1922) under the name 'urea stibamine' by heating P-amino-phenyl stibinic acid with urea solution. They have shown that the 'essential active principle' in urea stibamine is S-diphenyl-carbamide-4 : 4 distibinic acid

which is rendered water-soluble in the presence of protective colloids, and that this active principle is responsible for the remarkable therapeutic properties of urea stibamine. So far as I am aware, these findings have not been contradicted by any subsequent observer.

I would also point out that Gray *et al.* found fairly constant results from analysis of urea stibamine (Brahmachari), as shown in the accompanying table (the discrepancy in the antimony content of samples examined by them being due to varying amounts of the protective colloids present):

Carbon	Hydrogen	Nitrogen	Antimony
—	—	6·75	44·19
—	—	6·77	44·49
20·2	3·0	—	—
20·9	2·9	—	—
20·5	2·8	—	—
20·9	3·0	—	46·4
21·53	2·67	—	—
21·16	2·8	—	46·8
20·17	2·91	6·47	48·6

As already noted in NATURE[3], the divergent results obtained by different investigators were due to the fact that various manufacturers put on the market so-called urea stibamine which did not conform to my specification. This no doubt led to the conclusion of early workers that the so-called urea stibamine varied widely in its antimony content and was uncertain in its composition.

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[1] NATURE, **144**, 1103 (1939).
[2] *Proc. Roy. Soc.*, B, **108**, 54 (1931).
[3] NATURE, **145**, 546 (1940).

Cultivation of Bluetongue Virus in Fertile Eggs produced on a Vitamin-deficient Diet

Two of us (R.A.A. and J.H.M.) have made many unsuccessful attempts to infect mice, guinea pigs, rabbits, hamsters, hedgehogs, and chicks with bluetongue virus. Mice and guinea pigs were not rendered susceptible by blockading the reticulo-endothelial system with India ink, by deep X-ray therapy, or by maintenance on a vitamin-deficient diet of autoclaved oats. Finally no multiplication occurred in normal developing chick embryos when virus was seeded on the chorio-allantoic membrane, or in the yolk-sac (method of Cox, 1938).

Various workers, particularly in the United States, have shown that deficiencies and intoxications can be produced in eggs, if the hens are put on appropriate rations. Thus, eggs may be obtained that are low in vitamins A, D, and E, pantothenic acid, riboflavin and manganese: if the diet contains much selenium, for example, the embryo is poisoned. It occurred to one of us (J.D.W.A.C.) that although bluetongue virus did not multiply in a so-called normal egg, yet it might grow in some of these 'pathological' eggs. We decided to infect eggs produced on a diet known to be deficient in the curled-toe-paralysis preventive factor, which is possibly riboflavin. Eggs laid by hens on a supposedly normal ration were also used, as a control.

In both groups, each hen had free access to water and oyster-shell grit and got about 1·5 oz. crushed yellow maize each evening, and a little more than 0·5 oz. chopped, fresh lucerne each morning. Dry mash was left before the birds all day. The two mashes were made up as follows:

	Deficient Mash lb.	Normal Mash lb.
Yellow maize meal	30	30
Pollard	30	30
Wheaten bran	20	20
Meat and bone meal (55% protein)	7·5	15
White fish meal (68% protein) ..	7·5	0
Lucerne meal (average quality) ..	0	5
Dried brewer's yeast	0	3
Common salt	0·5	0·5

Basing our calculations on American figures, we may assume that a hen given the deficient mash ate about 180 micrograms riboflavin per day. As a hen needs at least 230 micrograms daily for her eggs to develop properly, it is obvious that the deficient ration is low in riboflavin. Hens on the normal mash took in the adequate amount of approximately 270 micrograms riboflavin each day.

We used the above deficient diet because our colleague, J. J. Bronkhorst, had proved in chick experiments that the fish meal and the ration as a whole was very low in the curled-toe-paralysis preventive factor. It was he, too, who kindly supplied all the eggs for these experiments.

The virus for the 'pathological' eggs was a 10 per cent saline emulsion of infected sheep spleen, filtered through an 860 mμ gradocol membrane; 0·2 c.c. was inoculated into the yolk-sac of each egg containing a six-day-old embryo and the eggs incubated at 36° C. Serial passage was carried out every 4 or 5 days by subinoculating yolk-sac emulsion into the yolk-sacs of 'pathological' eggs.

With this technique the virus has been carried through 21 egg-to-egg passages with irrefutable evidence of multiplication. The yolk-sac, the embryo, and the chorio-allantoic membrane contain virus; in one experiment each was shown to hold between 100,000 and 1,000,000 infective doses for sheep.

After 4 passages in 'pathological' eggs, the virus was able to grow in normal eggs and could be maintained in them easily. At the present moment, the adapted virus is in its 37th normal egg passage. One experiment has shown that the virus content of normal eggs may be much lower than that of 'pathological' eggs.

As a rule, infected embryos die in 4 or 5 days, and are cherry-red when dead or dying.

Whether it really is the deficiency of riboflavin in the diet that has enabled us to propagate bluetongue virus in 'pathological' eggs remains to be seen, and experiments will soon be conducted to settle the question. At least twenty deficiencies and intoxications and combinations of these can probably be produced in eggs, and it would seem as if 'pathological' eggs might support the growth of other viruses that have not been cultivated in normal eggs. However, we may mention that neurotropic and viscerotropic strains of horse-sickness virus and the rickettsias of rat typhus and tick-bite fever multiply no better in 'pathological' than in normal eggs.

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J. D. W. A. COLES.
R. A. ALEXANDER.

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April 24.

[1] Cox, H. R., *Pub. Hl. Rept.*, **53**, 2241–47 (1938).

Pining in Sheep not Curable by Cobalt Administration

WORK in Australia has shown that deficiency of cobalt in the diet is responsible for characteristic disorders of sheep and cattle. The view that a sheep disease known as 'pining' results from cobalt deficiency was advanced by Corner and Smith[1], who claimed that cobalt administration prevented and cured this disease north of the Scottish border. In our opinion these experiments were inadequately controlled. During a large-scale investigation of 'pining' in the Cheviot area south of the border, undertaken in collaboration with Dr. Taylor and Dr. Green of the Veterinary Laboratory of the Ministry of Agriculture at Weybridge, a well-controlled experiment was carried out to test the curative effect of cobalt on sheep suffering in varying degree from this disease. Cobalt solution was administered for five months to one half of the sheep, the other half being left as untreated controls. The death-rate from 'pining' was as high in the treated as the untreated group, and at the end of the experiment the treated sheep were no better than the controls as judged by body-weight records and hæmatocrite estimations. The details of this experiment have been described in a recent number of the *Veterinary Record*.

In a preliminary report[2] the view was expressed by us that 'pining' in the area concerned was caused by interaction between malnutrition and parasitic infestation, the worm species *O. circumcincta* being especially incriminated. Field investigation over the last three years has shown that 'pining' may be prevented either: (1) by feeding a special mineralized cake containing considerable quantities of calcium and phosphorus as well as small amounts of iron, cobalt, copper and other trace elements; or (2) by systematic anthelmintic treatment to remove worms. The mineralized cake may have prevented 'pining' by removing specific mineral deficiencies or by obviating undernutrition in the more general sense by supplying additional protein and calories. Although administration of cobalt has failed to cure pining, the possibility is not ruled out that specific deficiency of this element may play an initial part in some areas in the cause of pining by lowering resistance to parasitic disease. There is, however, no evidence for this view apart from the fact that parasitic infestation has been controlled and 'pining' prevented by feeding a mineralized cake containing cobalt as well as other trace elements. Our investigations are being extended with the object of eliminating the non-essential constituents from the pining-preventing cake and continuing observations upon anthelmintic treatment.

The claims of Corner and Smith for the specific significance of cobalt have been recorded in biochemical and medical as well as in agricultural literature, and it is therefore thought of general interest to direct attention to the article entitled "Pining not Curable by Cobalt Administration" being published in the *Veterinary Record*.

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May 6.

[1] Corner and Smith, *Biochem. J.*, **32**, 1800 (1938).
[2] Stewart and Ponsford, *J. Comp. Path. and Ther.*, **49**, 49 (1936).

Practical Science in Schools

A COMMUNICATION from my former biology master, Mr. A. G. Lowndes, in NATURE of June 1, p. 863, cannot, I feel, be allowed to pass without an answer. Since the time when I was very ably taught by Mr. Lowndes with plenty of laboratory work, I have become a biology examiner both in scholarships and School Certificate. I have, therefore, experienced the results of laboratory work in biology at school from two aspects in quite a short space of time, and my conclusions are the very opposite to those expressed by Mr. Lowndes.

Candidates for scholarships come up knowing advanced genetics, but when presented with a twig of larch they do not recognize it nor can they make a constructive effort to understand it. Similarly, they know all the details of stomatal mechanism, but the stoma that they draw would be quite incapable of opening and closing as described, and in one case a candidate admitted that he had never really properly examined one. I can, therefore, only believe that this result is achieved by too much book and lecture work and too little laboratory work. On Mr. Lowndes' scheme there will be a tendency for children to acquire knowledge which they do not properly understand because they have not handled the material for themselves.

Furthermore, I sincerely believe that a plant or animal which has been handled and cut up can be remembered very much more readily than the same plant or animal described and demonstrated. I remember that I learnt very much more of plant systematics at school when I collected and identified two hundred flowers than at the University when I saw many of them as demonstrations.

In this letter I only feel qualified to refer to biology, and so I may perhaps add that I believe one great asset of laboratory work is that one learns to draw accurately what is observed, and there cannot be too much of this, especially as many who come up to the university are very poor in this respect.

As I understand the problem, the solution would be for the universities to demand a smaller syllabus so that adequate time is allowed for laboratory work and the student becomes really grounded in the fundamental facts. I also find it difficult to subscribe to a statement quoted in an article on the same subject in the same number, namely, that the function of the teacher is "to stimulate wonder and imagination". I should have thought that a better function would be to stimulate understanding and appreciation.

I realize that *elementary general biology* is perhaps in a different category but I would still maintain my thesis, namely, that, so far as possible, actual examination of specimens helps one to remember better than any amount of talking.

V. J. CHAPMAN.

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June 2.

WE are glad to publish the above views of a member of a university staff who has also examined school students of biology. It should be borne in mind, however, that the majority of secondary school students do not proceed to a university, and furthermore only a minority of those who do so continue their studies in the science faculties. Science in

schools, therefore, is only one of several disciplines and should be treated as such. Over and over again the criticism that the school curriculum caters too much for the university candidate and too little for that majority, who complete their 'formal' education at the School Certificate stage, has been made in NATURE and elsewhere. This criticism is now meeting with a certain amount of response. Science teaching is still too much concerned with the presentation of factual information, by experiment or otherwise, and too little with its social and humanistic contacts. It is not the business of the schools to train academic, professional and industrial experts, but rather to produce intelligent and knowledgeable citizens. Dr. Chapman's views are justified from the point of view of a biologist looking for good, sound biological material to train as specialists. That scholarship candidates "come up knowing advanced genetics, but when presented with a twig of larch they do not recognize it" betrays an unbalanced syllabus. School science should "reveal the influence of scientific thought and achievement in the evolution of our present-day civilization—an appeal to social interest and utility". It has been shown that "factual knowledge and knowledge of scientific method can be imparted as successfully by demonstration as by practical work". While not advocating the complete abolition of practical work, we consider that *in schools* there is too much of it; it is too elaborate and demands more time than can be justified. (Editors of NATURE.)

Relation of Working Period to Output

THE production drive in Great Britain which started a month ago has led to a very great extension of working hours throughout industry. We would urge that this matter should receive the attention of scientists for the following reasons. It is necessary that a scientific attitude should be maintained towards the relation between hours of work and productivity of factory labour; it was established by experience during the War of 1914–18 that increased hours of work did not in all circumstances lead to greater production. Scientific workers as well as factory hands in industry and in Government service are also being asked to work longer hours, and it is uncertain what holidays will be granted.

During the "emergency fortnight" which began in the middle of May, several large firms required their staff to work a seven-day week of total hours varying from 50 to 70. We understand that in some of these firms the emergency arrangements have now come to an end: but even in these cases the 'permanent' arrangements provide for a six-day week of 48–60 hours, and the question of holidays has not been fixed.

While it is difficult to assess the productivity of a scientific laboratory, it is evident that excessive hours and reduced holidays and rest periods are likely to reduce the rate at which scientific and technical workers conduct their theoretical, experimental or supervisory work, and will also affect the quality of the work. It is also important to remember that mistakes made in scientific work may have very serious consequences, not only in increasing the risk of injury to the workers but also in turning out faulty products.

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June 17.

Points from Foregoing Letters

In a note on the early use of current-bedding to determine orientation of strata in the Dingle Peninsula, Eire, A. Lamont raises the question of the parts played by Patrick Ganly, John Kelly, and possibly G. V. Du Noyer in the application of this technique.

The cross-section of atomic oxygen for elastic collision with electrons has been computed using quantum mechanics by S. K. Mitra, B. B. Ray and S. P. Ghosh. Atomic oxygen is found to exhibit the Ramsauer effect, and the value of the collisional frequency in Region *F* (where atomic oxygen is predominant) computed by taking the appropriate cross-section, agrees with that obtained from radio measurements. Calculation by taking the gas-kinetic cross-section yields too low a value for the collisional frequency.

On examination of the diagrams that have been said by Messrs. Riley and Fankuchen to show the Patterson projection to be expected from an insulin crystal on the cyclol hypothesis, D. M. Wrinch finds that the angle of tilt used in their construction was not 6°, as stated by them, but 36°, and that the evidence of the diagrams is in favour of the cyclol hypothesis.

Investigating the hydration of anilides of higher normal fatty acids, B. A. Toms reports that ability to 'bind' water is shown only by those in which the fatty chain contains more than 14 carbon atoms. It is suggested that the bound water is held by a micellar structure.

By the hydrolysis of the methylated 'hot extract' of carrageen moss, E. G. V. Percival and J. Buchanan have isolated derivatives of 2-methyl and 2 : 6-dimethyl galactose; they discuss the bearing of this result on the structure of the polysaccharide.

E. G. Young finds that native and diluted egg-white in the ultracentrifuge shows only a single component, but diluted egg-white in the Tiselius electrophoresis apparatus shows five and sometimes six migrating boundaries. The behaviour of preparations of ovomucin and ovomucoid is also described.

J. H. Mason, J. D. W. A. Coles and R. A. Alexander find that bluetongue virus may be cultivated in fertile eggs laid by hens living on a vitamin-deficient diet. The possibility is that the vitamin concerned is riboflavin. After a few passages in such eggs, the virus grows easily in eggs laid by hens on a normal diet.

W. Lyle Stewart and A. Phyllis Ponsford find that 'pining' in sheep is not cured by cobalt administration. Deficiency of cobalt may be the initiating factor, lowering the resistance of sheep to worm infestation, death ultimately occurring from parasitic disease.

RESEARCH ITEMS

Blood-Groups and Castes

THE distribution of blood-groups in certain castes of the United Provinces of India has been studied by D. N. Majundar of the University of Lucknow (*Science and Culture*, **5**; 1940). Recently tests were carried out in connexion with an anthropometric survey. Tests on 175 subjects belonging to three castes gave results as follows: Kayasthas (47) O 41·4, A 19·7, B 30·6, AB 8·3; Khatris (36) O 36·5, A 21·8, B 35·0, AB 6·7; Chamars (92), O 38·3, A 13·3, B 38·3, AB 10·0. Bengal data (MacFarlane) show that percentages of A and B increase from the higher to the lower castes, and that the highest percentage of O is among the caste Hindus. The increase of B among the Khatris of the United Provinces is perhaps due to a greater admixture with inferior races. The Chamars possess a high percentage of B and O—38·3 O as against 30·9 O among non-caste Hindus of Bengal; while the Kayasthas have 41·4 O. On these results it is premature to form any hypotheses; more data are required. The castes have been endogamous groups for ages. If O underrates the degree of isolation, the still large percentage of O in India (43·0) among Brahmins and Kayasthas of Bengal and (41·4) among Kayasthas of the United Provinces, compared to 45·0 among Americans, 46·4 among English, 37·3 in Germany, indicate a racial affiliation with the various branches of the white race. On the other hand, if there may be genes for O in the low-caste people with a high mutation rate for B, the decrease among the higher castes of A, which is higher among the white races, and a high value of B suggest a racial admixture, and the more we know of blood-groups the greater the possibility of determining the extent of this admixture. The popular belief that the Kayasthas of Bengal differ ethnically from those of the United Provinces is not supported.

Eye of a Blind Cave Fish

THE blind cave characin, *Anoptichthys jordani*, described in 1936 is the first fish of the order Heterognathi to show loss of ocular structure. A histological investigation of the eye by E. B. Gresser and C. M. Breder, jun., shows that while the eye has definite layers, they are of poor development, so that while the primitive optic vesicle has undergone its first invagination, it appears at this stage to have ceased to differentiate beyond a pigment layer and a retinal layer (*Zoologica*, **25**, 113; March 1940). The external musculature is present and an optic nerve has an outline. Whether the eye stops in development because no lens develops and produces in turn the fusion of the poorly developed primary vesicle into a cyst, or vice versa, the eye has not advanced to a stage when vision is possible. The authors consider that the histology indicates that in this case blindness is due to a stoppage in development of the eye structures at an early stage, rather than to degenerative changes at a more advanced stage; and they consider that the origin of such a defect as is here recorded is more likely to be due to a chance mutant form accidentally associated with cave life, than to the gradual adaptation of a seeing fish to the conditions of cave darkness.

A New Method of Rendering a Poisonous Snake Harmless

RECENTLY, Duval B. Jaros has perfected an electrocoagulating device, with high-frequency current at about one million cycles a second, whereby the escape of venom from the poison gland of a snake and its passage to the fang is prevented by the destruction of a portion of the duct (*Zoologica*, **25**, 49; March 1940). The operator can manage the entire procedure without assistance and in safety; the snake is not disfigured and its habits seem in no wise affected by the operation. Thirty-six crotalid snakes, ranging in size from eight inches to four feet, were treated and were thriving normally after forty-five weeks, the result of the occlusion of the duct apparently being permanent. In the performance of the operation the author introduced three novelties, a practical device for holding the snake, a cheap and efficient operating knife, and the use of Michel surgical clips to eliminate all danger of the operator being bitten.

Mycology in China

SEVERAL papers which show increasing study of mycology in China were contributed to the journal *Sinensia* in 1937 and 1938. S. C. Teng and S. H. Ou published part 7 (**9**, Nos. 5–6; September 1937) and S. C. Teng part 8 (**9**, Nos. 3–4; May 1938) of "Additional Fungi from China". S. C. Teng and K. L. Teng have also made a preliminary study of the Myxomycetes of China (**8**, Nos. 5–6; Sept. 1937). These are all detailed descriptions of species, most of which are familiar to the British mycologist, but a few new taxonomic designations have been found necessary. These include *Quaternaria microspora*, *Rosellinia culmicola*, *Clypeosphœria radicicola*, *Endoxylina citricola*, *Chrysomyxa Bambusae* and *Periconia bambusina*. The two last-mentioned occur on bamboo; the others upon deciduous twigs. Some of the work of description was performed in Nanking in October and November 1937, during the disastrous air-raids upon that city.

Life-cycle of Allomyces

RALPH EMERSON has described a genetical means of discovering the life-cycle of Allomyces (*Mycol. Soc. Amer.*, Dec. 30, 1939). Species of the sub-genus Euallomyces have an asexual generation alternating with a sexual one. Zygospores give rise to secondary sporophytes, while spores from resistant sporangia give rise to sexual plants which are monœcious. The sexual plants bear male and female gametangia of different colour, and their position differs in different species. Crosses were made between species differing in these and other characters. Segregation occurs after the formation of resistant sporangia, but before the development of the mature gametophyte. The sex-determining mechanism is, therefore, phenotypic in the gametophyte.

Linkage Group in the Sweet Pea

THE fourth linkage group of the sweet pea now consists of five pairs of genes (R. C. Punnett, *J. Genetics*, **39**, 301–308; 1940). The characters acacia, dull flower, absence of flake-modifier, glabrous, picotee, together form a linkage group of at least 119 cross-over units. C. D. Darlington in an appendix

to this paper shows that the largest two chromosomes are about 148 crossing-over units long; therefore this linkage group covers almost the whole of one of these long chromosomes. A further allelomorph G'' has been added to the flake multiple allelomorph series G, G'. G'' causes less pigment production than G'.

Genetics of Wood-Lice

THE woodlouse, *Armadillium vulgare*, is a fairly easy animal to rear in culture (H. W. Howard, *J. Genetics*, **40**, 83–107; 1940). Two varieties, red and yellow, respectively, are dominant to the commoner black and grey varieties, while two rare varieties C and D are dominant and sex-linked. The sex ratios of a progeny is rarely 1 : 1; some broods consist only of males or only of females, while others are weakly arrhenogenic or weakly thelygenic. This is determined by the female parent. The author follows Vandel's hypothesis that the female is the heterozygous sex, and that the segregation of the sex chromosomes into eggs and polar bodies is controlled by the cytoplasm. Several wild populations of *A. vulgare* were found to have an excess of females.

Applications of Statistics to Palæontology

As a result of a statistical investigation of some freshwater lamellibranchs (Anthracomya) from the Coal Measures of Scotland (*Quart. J. Geol. Soc.*, **96**, 13–37; 1940), D. Leitch has developed a method which may prove of wide application in the study of fossil groups where abundant specimens are available showing wide ranges of variation in which they appear to overlap with comparable groups at other stratigraphical horizons. He finds that regression equations calculated on various dimensions of these shells are applicable to practically all the members of the group investigated, but that a large proportion of the forms from other horizons do not satisfy the equations.

Mechanical Integrity in a Circuit-Breaker

A PAPER on the "Mechanical Integrity in the Design of Electrical Circuit-Breakers" was read before the Institution of Electrical Engineers on May 8 by M. C. Hunter, of the British Thomson-Houston Co., Ltd. Electrical investigation has been carried out since the inception of the electrical circuit-breaker to produce infallibility of operation, and more particularly to ensure that the breaker will open when required to do so, regardless of the time it may have remained in a state of rest, under load conditions, without attention. There are many other mechanical requirements to be met such as speed of making, speed of breaking, contact pressure and correct buffering for absorption of energy at each end of the stroke, but the quality of 'opening whenever called upon' is the most fundamental of all. No accelerated proving method is available which will fully replace the natural sequence of closing the breaker, leaving it on load for, say, six months and observing the result after tripping. The arrangement of parts, accelerating springs, etc., therefore demands that there shall exist an expelling force which will at all times guarantee the opening of the contacts. The determination of the required magnitude of this expelling force is not easy, and ultimately depends on the required degree of certainty with which the breaker must open under the most onerous conditions, such as inattention, rust, 'glueing in' with heat, slight freezing of the contacts, misalignment, contact roughness due to wear, contact erosion, etc. The required value may be considered to be in the nature of a 'factor of safety', or better a 'factor of assurance'. This term is used in connexion with both the breaker mechanism and the operating mechanism. The author, by means of curves and calculations, shows how approximate values of this assurance factor can be obtained which would be of value in practice.

Precision Measurements in the Hydrogen Spectrum

AMONG the fundamental applications of quantum theory to atomic spectra are the quantitative calculation of the Rydberg constant in terms of e, h, c, etc., and the prediction of the fine structure of the Balmer lines. The latter, as calculated from the relativistic wave-mechanics of Dirac, is the same in separation and intensity distribution as that given by the old theory of Sommerfeld. J. W. Drinkwater, Sir Owen Richardson and W. E. Williams (*Proc. Roy. Soc.*, A, **174**, 164) have investigated the wave-lengths and structures of the α-lines of hydrogen and deuterium, using the reflecting echelon of Williams, which is for this purpose a new and advantageous spectroscopic technique. The source of light was a discharge tube cooled in liquid air. The value of e/m for the electron calculated from the wave-lengths is in good agreement with recent measurements on free electrons. This removes a suspicion that there was a systematic difference between 'spectroscopic' and 'free electron' values of this ratio. The separation and intensities of the fine structure components were in satisfactory agreement with the theory. The limit to the accuracy of this test was apparently set by a background of the hydrogen molecular spectrum.

Energy in the Solar Ultra-Violet

A REPORT of five years work at the Mount Wilson Observatory on the energy distribution in the ultra-violet solar spectrum has recently been published by E. Pettit (*Astrophys. J.*, **91**, 159; 1940). The observations differ from the author's previous work at Tucson, Arizona, in being on the radiation from the centre of the disk, rather than on integrated sunlight. The light was fed from an aluminized siderostat mirror through a double quartz monochromator on to a vacuum thermopile, the second slit of the monochromator being made adjustable so as to pass 100 A. of the spectrum at all wave-lengths. The results, reduced to no atmosphere by transmission coefficients which agree well with those of the Smithsonian observers, yield spectral energy curves similar to those obtained at Tucson: the intensity drops by 50 per cent between 4000 A. and 3800 A., remains nearly constant to 3250 A., and then falls at a linear rate with wave-length to a very low value at 2920 A. To eliminate so far as possible the effect of Fraunhofer line absorption, auxiliary energy-curves were obtained with a 21-ft. concave grating monochromator used in conjunction with a photocell. By sketching in the continuum between the lines on such traces, coefficients were derived by which the thermoelectric curve could be reduced to one referring to the continuum. Even so, however, this curve shows most of the previously noted depressions in the ultra-violet, and is still far removed from that of a black body. The absorption spectrum of O_3, which has formed the subject of a special laboratory investigation, is shown to be insufficient to account entirely for the form of the curve, and its departures from the black-body type are to be regarded as real.

RECENT ADVANCES IN MARINE BIOLOGY

By Dr. N. B. Eales

THE recently published Journal of the Marine Biological Association contains nineteen papers on biological subjects, and the report of the Council for the year 1938.* The report records the bequest to the Association of £6,500, instruments, books and apparatus under the will of the late E. T. Browne. A research room has been named the Browne Memorial Room, and will contain furniture from Mr. Browne's laboratory and his valuable reference library on Cœlenterata. The new constant temperature rooms are in use and other improvements have been made in the buildings, especially in accommodation for research workers.

Six papers record ecological investigations. P. Hartley gives an account of the tuck-net fishery on the fine mud of the Tamar and Lynher estuaries. The net was used at monthly intervals for two years in the Saltash area, and the estuarine fishes, their food, migration and frequency distribution are described. Most of the fish go to the sea to spawn. Collateral invasions of cormorants, jellyfish and cephalopods seriously impair the value of the fishing.

A. Milne, in the fourth of his studies on the ecology of the Tamar estuary, deals with the fauna and flora of floating buoys. Weeds attach themselves in considerable numbers and compete with mussels for a site. Sessile animals are to be expected, but isopods, amphipods, crabs, worms and echinoderms live in the crevices. As the result of permanent submergence, however, some littoral species cannot survive, for example, *Littorina littorea*. The extent of estuarine penetration was studied.

J. Colman surveyed the well-known collecting area known as Church Reef, Wembury Bay, and examined the invertebrate fauna in relation to eight species of seaweed. He records 35 animal species new to the Plymouth Fauna List, out of a total of 177. There are surprising omissions, for example, *Obelia geniculata*, Tectibranchs and Nudibranchs, and the compound Tunicates *Didemnum asperum* and *D. maculosum* on the Laminaria holdfasts. A large number of Polychætes was found. A comparison of terrestrial and marine faunas elicits the fact that the marine fauna is the denser of the two. *Ascophyllum nodosum*, with its epiphyte *Polysiphonia lanosa*, houses the greatest number of individuals.

C. Rees studied the ecology of a mud flat in the Cardiff area, by means of horizontal and vertical samples. The microfauna and the chemical and physical factors of the water were investigated and a quantitative survey of the macro- and micro-fauna were attempted. The interactions of the observed phenomena are discussed.

H. B. Moore, in his second paper on the biology of *Littorina littorea*, made a survey of the zonation of this species in five localities in the Plymouth area and one on the island of Skye. Unable to endure constant immersion, this species has a definite lower limit; it does not extend below low-water springs and is most abundant at mean low water of the neap tides. The upper limit varies with the locality and algal growth, but the molluscs require wetting by the sea every tide, and do not reach above high water neaps. Young individuals occur near the upper limit, the largest near the lowest levels. G. Spooner and H. B. Moore, in their sixth paper on the intertidal muds of the Tamar estuary, record the macrofauna. Quantitative samples were taken and provided data regarding population density, up-river penetration and vertical distribution. The effects of water currents at low tide levels on population and the zonation of certain species were also studied. This fauna supplies food for fishes brought in by the flood tide and for wading and shore birds during the ebb tide period. The paper is profusely illustrated with graphs and distribution charts.

There are three papers dealing with life-histories. E. H. Myers worked on the life-cycle of four species of the foraminiferan Discorbis. Since the flagellate stage occurs within the test, it is possible to demonstrate the production of 'zoospores' by crushing. In *D. patelliformis* 250–300 triflagellate zoospores—more correctly gametes—are formed within one shell. At this period, however, two or more individuals unite to form multiple tests, each participant being a mononucleate megalosphere. After fertilization of the gametes multinucleate microspheric individuals with two or three chambers are formed within the megalospheric test, and each undergoes a sexual reproduction to form mononucleate megalospheric individuals again. The complete life-cycle can be completed in just over 64 days.

Marie Lebour adds to her valuable researches on the larval stages of Crustacea an account of the larvæ of the Pandalidæ. F. Gross has two papers dealing with the life-history and osmotic relations of the diatom *Ditylum brightwelli*.

Contributions of a biochemical and physiological nature include a study of the nitrogenous and phosphorus requirements of phytoplankton, and the intensification of their growth rate by chemical means by H. Harvey, of the phosphorus and iron requirements of two species of Sagitta by R. J. Harrison, and on the average obliquity of illumination under water by W. Atkins and H. Poole. They describe a cubical photometer for obtaining their results.

The variation in the type of inheritance shown by echinoid hybrids in different years led S. Hörstadius to study crosses between *Psammechinus miliaris* ♀ (*Z* type from the shore and *S* type from the Eddystone) and *Echinus esculentus* ♂. It is remarkable that during 1909–11 the inheritance was maternal, in 1912 it was paternal, while in 1932 it was mixed. The effects of temperature, *p*H and salinity are discussed, but no definite cause for the difference was established.

There are three investigations on subjects of economic importance. F. S. Russell continues his records of the seasonal abundance of young fish, although unfortunately, owing to the War, the record for 1939 stops at the end of August. Previous records show that the last four months of the year are negligible, since the earlier months cover fully the period of production. The 1939 results are the worst

* Journal of the Marine Biological Association of the United Kingdom, Vol. 24, No. 1. (Cambridge: At the University Press, 1940.)

since the slump year of 1924, despite the fact that no change in the plankton was noted. J. H. Orton reports on the oyster beds of the Fal Estuary. On the banks the beds are in poor condition, largely owing to dirty culch. Overgrowth of sponges and Lithothamnion is a troublesome factor. In the river, conditions are better and it is suggested that clean culch from this region should be spread over the banks every June to assist in recovery. *Crepidula fornicata* has not appeared in the area. The experimental rearing of oyster larvæ over five seasons at Port Erin Biological Station provides the material for a lengthy report by J. M. Bruce, Margery Knight and Mary Parke. This important piece of work deals chiefly with the food supply of the larvæ, and the cultivation of algal zooids acceptable to them. It is in some respects supplementary to H. A. Cole's work on the biological and physical conditions affecting oyster culture at Conway. Six flagellate organisms were eventually chosen and cultivated and were fed to the veliger larvæ under stabilized biophysical conditions, either separately or mixed. The most successful were those labelled *H* and *I*, greenish yellow or golden brown flagellates 3–6 μ in diameter. Using them as food, more than 90 per cent of the larvæ settled as spat. The adaptation of the experimental results to commercial practice is the next problem to be solved.

LARGE-SCREEN TELEVISION PROJECTION

THE application of television has so far been restricted by the difficulty of obtaining received pictures comparable in size and brightness with those produced by the cinematograph, whether used in the home or in places of public entertainment. Consideration of the matter leads to the conclusion that this objective is unlikely to be achieved until it is practicable to apply the principles of optical projection of the pictures, using a standard form of light source of a magnitude suitable for the size of picture required.

In an article published in the February–March issue of *Electronics and Television and Short-Wave World*, Dr. A. H. Rosenthal describes a new electronic device by means of which such projection may be realized, without the disadvantages accompanying the use of an intermediate film on which the picture is first recorded photographically and then projected in the usual manner. The principle of the device is based upon the discovery by E. Goldstein in 1894, that certain materials, normally transparent to visible light, become coloured, that is, more or less opaque, when they are subjected to bombardment by cathode rays. Examples of such materials are the halides of the alkaline earth group, and potassium chloride has been used in the application of this discovery to television reception.

In the instrument developed by Dr. Rosenthal, which he terms a 'Skiatron', the screen of the cathode-ray receiving tube is replaced by a plate of potassium chloride crystals, mounted between two light-transparent electrodes. As the plate is scanned in the normal manner by the beam of electrons, an opaque deposit is produced, the density of which is everywhere proportional to the instantaneous intensity of the beam. The screen thus carries during each frame period a complete quasi-stationary picture, which may be projected optically in a manner similar to that employed with a cinematograph film. The opaque deposit is removed by the application of a steady electric field between the electrodes placed on either side of the crystal, the speed of obliteration increasing with the field strength and also with increase of temperature of the crystal.

In the instrument under development, the magnitudes of these quantities are chosen so that the 'picture' deposits are removed in the interval between successive scannings. Owing to the fact that the picture being projected is quasi-stationary, as compared with the continuously varying one produced on the fluorescent screen of the usual cathode-ray tube, the picture repetition frequency used in the 'Skiatron' can be reduced to a value just sufficient to avoid flicker. If this advantage is substantiated in practice, the effective band of radio frequencies required by the television transmitter will be reduced.

In the article referred to, Dr. Rosenthal illustrates an arrangement of using three of these special tubes for reproduction of coloured pictures. Each cathode-ray tube with its special crystal screen and a suitable light filter operates at one of each of the three primary colours used, and the illumination is projected directly through the three screens in succession to obtain the coloured resultant picture.

PROBLEMS OF EVACUATION

THE report of an inquiry, which has been pursued by the Department of Social Science of the University of Liverpool, financed by a grant from the Charities Fund of the Liverpool Council of Social Service, into problems of evacuation has now been published under the title "Our Wartime Guests—Opportunity or Menace" (Liverpool: University of Liverpool Press. London: Hodder and Stoughton, Ltd., 6*d*. net). It emphasizes the importance of a determined effort to profit as much as possible from the mistakes of what may prove to be only the first of a series of evacuation schemes. Like the interim report, which dealt with the evacuated areas, the present report is based on house-to-house visiting, this time in the reception areas. The results of these 412 interviews lead to the reassuring conclusion that the evacuation scheme, despite its voluntary basis, has not entirely broken down. The majority of the hosts behaved splendidly and succeeded in making the children entrusted to them happy. Many of the parents co-operated to the best of their abilities.

That the scheme was not a complete success was due to faulty organization in the billeting of dirty, verminous and enuretic children; the removal of children from their billets by parents on the impulse of the moment; the unwillingness of some hosts to

accept the heavy extra work and surrender of their freedom involved; and the influencing of public opinion against the scheme by those who did not wish to co-operate. Moreover, those who believed the scheme was workable did not express themselves strongly enough, and no central authority was appointed in reception areas to deal with the problems which arose, to give a lead to parents and hosts who were uncertain in their attitude and to undertake active propaganda to influence public opinion in favour of the scheme. Such a central authority in each district ready to offer advice on all difficult problems, particularly psychological ones of behaviour, could undoubtedly have smoothed out many of the difficulties and led to the children remaining in the safe areas. So far as there have been breakdowns in the scheme, the administrative machinery would appear to be at fault rather than any fundamental weakness in the ties which bind our community together, or absence of public spirit on the part of hosts or parents of evacuated children. If the authorities concerned had used the services of tutors qualified in medical psychology or carried out a short research before the scheme was drawn up, many mistakes would have been avoided.

The report also stresses the possibility of basing action on precise knowledge with the development of social psychology. It directs attention to the need for extended research on enuresis and its treatment, the widespread existence of which was indicated in the inquiry. The scheme also demonstrated that the general standards of cleanliness and hygiene leave much to be desired, and the appreciation of the value of education is much lower in a certain group of the population than might have been supposed. Much could be done to correct this attitude by strengthening the school medical service, and the use of new means of education and propaganda.

In regard to the apportionment of responsibility for individual failures, the inquiry showed that 60 per cent of the parents were to blame for taking their children home without justifiable cause, 30 per cent of the hosts sent the children away because they did not wish to co-operate and only 10 per cent of the children returned because they were ill-behaved or fretting.

LIMITATION OF TRANSFORMER NOISE

TRANSFORMERS are particularly suited for outside use in outside distribution of electricity, owing to the facility with which they can be installed and the saving effected, but if they are a nuisance to dwellers in their neighbourhood, something has to be done immediately to suppress their noise. Noise prevention is a matter for co-operative investigation, and this was the reason why the Electrical Research Association (E.R.A.) formed a committee in 1934, composed of gas, electric and water engineers, under the chairmanship of Prof. B. O. Kapp, to consider the best means of eliminating this trouble. Definite contributions have been made to our knowledge by this committee, and by papers and discussions on the subject contributed to the engineering societies. An interesting paper on the limitation of transformer noise was contributed to the Institution of Electrical Engineers on March 28, the authors being B. G. Churcher and A. J. King, of the Metropolitan-Vickers Electrical Co., Ltd.

Before considering means for reducing noise to allowable proportions, we should be able to determine its value both as regards quantity and quality. In the case of transformers, the latter is not so important as in the case of some kinds of machinery in which the sound varies in pitch. Nevertheless, the annoyance which can be caused by transformer hum is very real.

It is axiomatic that trouble should, if possible, be eliminated at its source. The authors and those who took part in the discussion on their paper showed there is very little to be gained by altering the design of transformers within permissible commercial limits. Dr. Swaffield has recently shown that the main cause of transformer noise is magneto-striction, that is, vibration due to change in length and in the area of the core that occur together, under the influence of the impressed magnetic field. The old idea that tightening core bolts and clamping could effect appreciable improvement has been shown to be wrong. Attempts to limit the effects of magneto-striction by reducing the density of the magnetic flux yield only very slight relief at a great cost.

The *Electrical Review* of April 5 gives a good illustration of the material values of the study that has been expended on this subject. When the 75,000 kva. transformers were installed at Fulham Power Station about three and a half years ago, all means were taken to avoid being a cause of offence. The transformers were run at a low flux density and the tanks rested on rubber pads. Each transformer was housed in a brick chamber without openings. This last precaution was probably much the most effective.

Many think that efforts to obtain a silent transformer will probably be fruitless. Attenuation of unavoidable sound offers the most promising field of attack. Hence the authors put forward, as a less costly alternative to bricking-in, where conditions would otherwise make that necessary, a scheme of barriers within a larger tank which would absorb both radial and longitudinal sound waves. Even apart from the dominant consideration of the background level of noise, almost every case has to be considered on its merits. Distance and structure of the surrounding houses are principal factors, but even here resonance sometimes gives rise to curious phenomena.

The first need appears to be to secure a standard attenuation acceptable in ordinary conditions, and then to provide means to predict with certainty the additional attenuation required to meet the peculiarities of local circumstances. In addition, the establishment of noise-levels regarded as tolerable would be helpful, if only because (since psychology enters into the equation) objection to constituted standards would appear unreasonable. It may be fairly claimed that research on present lines augurs well for an economical solution of the noise problem, without departing from the well-established principles of transformer design.

SEVENTY YEARS AGO

NATURE, vol. 2, June 30, 1870

Natural Science at the Royal Academy

IN an article under this title by John Brett, some suggestions are made as to the spirit in which the student of science should pay a visit to the Royal Academy, and at the same time there are some shrewd cuts at the artist fraternity.

"The central motive of fine art may be most compactly expressed by the simple word beauty. . . . Go to the Academy to seek for it. Do not expect much of it; for amongst the four or five hundred essayists on canvas there represented, a good many, perhaps more than half of them, would repudiate that fundamental principle." The student of science should take his beauty in small doses, and enjoy it freely in his own way. Then he should examine the pictures analytically, to see whether any example of beauty depends on a violation of the laws of Nature; "whether he has come across a lovely monster". Finally, he must remember that art, in England, is in its infancy.

"What is the moral of all this? Simply that the scientific men pay too little attention to the broader aspects of the visible world; while the artists on their part pass by the clear fountain of natural beauty, and content themselves with dreamily sipping lukewarm water from the corroded vessels of their forefathers; the one group of doers standing apart from the other; whereas, if either would go to school with the other, they would, in my opinion, each stimulate and aid the labours of the other, and divide between them a far larger share of the spoils of the world."

England to India Cable Completed

THE completion of the deep-sea cable between Falmouth and Bombay was celebrated on June 23 by an entertainment given by Mr. Pender, chairman of the British-Indian Submarine Telegraph Company, at which royalty largely assisted. Complimentary messages were exchanged between the Viceroy of India and the President of the United States, the distance of 8,442 miles being accomplished in forty minutes. This is the first instance of direct telegraphic communication between India and America. Other messages were dispatched, including one from the Prince of Wales to the Viceroy, which presented "the comic side" of telegraphy; though dispatched soon after twelve at night, and only nine minutes on its way, it reached Lord Mayo at five in the morning, when his lordship was, naturally enough, fast asleep. "What will be the result when the earth is completely girded by a telegraphic cable, and a message is sent to the antipodes? The question between night and day will be expanded to one between to-day and to-morrow, to say nothing of yesterday."

THE opening portion of a paper by Dr. H. Charlton Bastian, F.R.S., entitled "Facts and Reasoning concerning the Heterogeneous Evolution of Living Things" appears. This paper was originally prepared for the Royal Society, but when Dr. Charlton Bastian found that an evening could not be allotted to its reading and discussion, he submitted it to NATURE for immediate publication. The author describes his experimental evidence for spontaneous generation of organisms.

UNIVERSITY EVENTS

LONDON.—The following degrees have been conferred: *D.Sc.* on Miss Phyllis A. Clapham (London School of Hygiene and Tropical Medicine); Mr. J. G. Davis (University College); Mr. A. A. Miller (University College); Mr. M. C. Vyvyan, a recognized teacher at East Malling Research Station; *D.Sc.* (*Engineering*) on Mr. H. G. Taylor (Imperial College of Science and Technology and Battersea Polytechnic).

APPOINTMENTS VACANT

LECTURER IN MECHANICAL ENGINEERING—The Principal, Technical College, Gainsborough, Lincs. (July 5).

ASSISTANT LECTURER IN BOTANY—The Registrar, University Manchester, 13.

REPORTS AND OTHER PUBLICATIONS

(not included in the monthly Books Supplement)

Great Britain and Ireland

Philosophical Transactions of the Royal Society of London. Series A: Mathematical and Physical Sciences. No. 796, Vol. 238: Relaxation Methods applied to Engineering Problems, 5: Conformal Transformation of a Region in Plane Space. By R. W. G. Gandy and R. V. Southwell. Pp. 453–476. 3*s.* 6*d.* No. 797, Vol. 238: Tides in Oceans bounded by Meridians, 4: Series Solutions in terms of Angular Width of Ocean, 5: Solutions by use of Finite Differences: Semidiurnal Tides. By A. T. Doodson. Pp. 477–512. 5*s.* 6*d.* No. 798, Vol. 238: Theory of the Vibrations of the Sodium Chloride Lattice. By Dr. E. W. Kellerman. Pp. 513–548. 6*s.* 6*d.* (London: Cambridge University Press.) [36

Carnegie United Kingdom Trust. Twenty-sixth Annual Report, 1939. Pp. vi+45. (Dunfermline: Carnegie United Kingdom Trust.) [36

Other Countries

Proceedings of the United States National Museum. Vol. 88, No. 3079: Report on Certain Groups of Neuropteroid Insects from Szechwan, China. By Nathan Banks. Pp. 173–220. Vol. 88, No. 3088: The Ichneumon-Flies of the Subfamily *Neorhacodinae*, with Descriptions of a New Genus and Three New Species. By R. A. Cushman. Pp. 523–528. (Washington, D.C.: Government Printing Office.) [315

United States Department of the Interior: Office of Education. Bulletin, 1939, No. 5: Bibliography of Research Studies in Education, 1937–1938. By Ruth A. Gray. Pp. xv+400. (Washington, D.C.: Government Printing Office.) 35 cents. [315

American Philosophical Society. Year Book 1939. Pp. 494. (Philadelphia: American Philosophical Society.) [315

U.S. Department of the Interior: Office of Education. Bulletin, 1939, No. 8: Public Education in the Panama Canal Zone. By Katherine M. Cook. Pp. v+64. (Washington, D.C.: Government Printing Office.) 15 cents. [36

Imperial College of Tropic Agriculture: Low Temperature Research Station. Memoir No. 4: Studies in Tropical Fruits, 6: A Preliminary Consideration of the Solubility of Gases in relation to Respiration. By E. R. Leonard. Pp. 825–844. Memoir No. 15: Preliminary Observations on the Refrigerated Gas Storage of Gros Michel Bananas. By C. W. Wardlaw. Pp. 44. (Trinidad: Imperial College of Tropical Agriculture.) [36

Illinois Biological Monographs. Vol. 17, No. 3: The Branchiobdellidae (Oligochaeta) of North American Crayfishes. By Clarence James Goodnight. Pp. 75. (Urbana, Ill.: University of Illinois Press.) 1 dollar. [36

Field Museum of Natural History. Report Series, Vol. 12, No. 1: Annual Report of the Director to the Board of Trustees for the Year 1939. (Publication 468.) Pp. 173+12 plates. (Chicago: Field Museum of Natural History.) 1 dollar. [36

Catalogues

Photographic Pioneers. Pp. 20. (London: Burroughs Wellcome and Co.)

The Microid Gas Generator. (GT.1298.) Pp. 2. The Microid Lever Balance. (GT. 1299.) Pp. 4. The G.L.C. Constant Volume Gas Analysis Apparatus. (GT. 1302.) Pp. 4. Streamlined Hydrometers. (GT. 1303.) Pp. 4. 'Pyrex' Sintered Glassware. Pp. 8. (London: Griffin and Tatlock, Ltd.)

A Catalogue of Miscellaneous Books. (No. 649.) Pp. 66. (London: Francis Edwards, Ltd.)

A Catalogue of Rare and Important Works on Botany and Horticulture. (No. 575.) Pp. 24. (London: Bernard Quaritch, Ltd.)

Clarification and Sterilisation. (Publication No. 366.) Pp. 12. (London: A. Gallenkamp and Co., Ltd.)

OFFICIAL ANNOUNCEMENTS

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UNIVERSITY OF SYDNEY

Applications are invited for Chair of Obstetrics. Salary £2,000 per annum. Duties commence December 1, 1940. Further particulars from the Secretary, Universities Bureau of the British Empire, 88a Gower Street, London, W.C.1. Applications to be sent by September 30 to the Registrar, The University of Sydney, New South Wales.

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