NATURE

SATURDAY, MAY 10, 1924.

CONTENTS.

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

Advertisements and business letters should be addressed to the Publishers.
Editorial communications to the Editor.

Telegraphic Address: PHUSIS, LONDON.
Telephone Number: GERRARD 8830.

Mathematical Physics in University and School.

IT was suggested to us recently by a distinguished mathematician that for a considerable time to come much of the research in physics will consist in working over our present knowledge with the view of the restatement of the laws in conformity with the theory of relativity. However this may be, the present is an appropriate time for a review of the mathematico-physical education of England in order to estimate its value as a general education, and in particular to estimate the degree to which these studies are producing a supply of workers suitably equipped for undertaking this restatement of the laws.

The whole region of knowledge with which we are concerned divides itself naturally into four fields. The first field is that of pure mathematics, and its function is to furnish the tools for use in the remainder of the region. The second field is applied mathematics and consists chiefly of mechanics ; this requires a real equipment of pure mathematics and only the slightest knowledge of physics. A third field is that of physics proper, for which a very moderate command of mathematics is sufficient. The fourth field is mathematical physics, and requires a thorough knowledge of both mathematics and physics.

In our inquiry for suitable workers for the cultivation of these fields we naturally turn to the University of Cambridge, and if we take the graduates of the last forty years we shall be including most of the workers who are still active. Taking first the mathematical tripos, we look through the lists and find a number of men doing excellent work in such subjects as astronomy, relativity, and the philosophy of mathematics ; that is to say, in our first two fields of pure and applied mathematics. We know of one case only in which a mathematician has added the full equipment of the physicist to his original mathematical outfit. We look next through the natural science tripos lists and among the research graduates. Again we find excellent work being done, but in this case the work is practically confined to our third field, that of physics proper. Among the younger mathematicians a few are turning their attention to physics ; these have a prospect of becoming mathematical physicists in time, but at present they have not earned the title. Thus, among the men whom Cambridge has produced in these forty years, we are unable to find more than one leading worker of the type we have in mind who possesses the double equipment required for progress in the field of mathematical physics.

This field was not always left uncultivated. Let us look at the graduates of the forty-year period preceding the period we have been discussing. There we find numbers of men who tackled indiscriminately problems from all parts of the mathematico-physical region. Witness such names as Stokes, Kelvin, Maxwell, Rayleigh, Poynting, J. J. Thomson. The view has been advanced that the absence of work in mathematical physics is the natural result of the swing of the pendulum; that the earlier forty-year group had completed work on the problems that existed in their time and a lull was inevitable until new problems manifested themselves. This view, however, is not convincing. Is it, for example, a mere accident that in Britain no work comparable to that of J. J. Thomson's mathematical investigation of the structure of the atom is being carried on while work of the first importance is being done abroad?

The true reason of the difference between these two periods is not far to seek. A change was made in the mathematical tripos at Cambridge in the year 1882 by which the centre of gravity was seriously shifted. Before that year the tripos contained almost as much physics as mathematics; since then, the physics has been almost negligible. There was real necessity for some change in the tripos at that time. The mathematico-physical region had expanded until no individual could cover the whole of it, and some reduction of the range of the tripos was inevitable. That the method of cutting out the physics should have been chosen was the height of misfortune. If the reformers of that day could have foreseen relativity and the problems that would consequently arise, their decision would have been different. They would have kept mathematics and physics together as a single indivisible whole and would have reduced the total mass by severe pruning. Each item of the tripos programme, whether mathematical or physical, would have been judged by its importance for development on relativist lines, and only those found to be absolutely necessary retained. All students would thus have been familiar with the main line of development, while the discarded items would have remained as additional possibilities for particular students who happened to be specially attracted to them, to be taken either as post-graduate studies or (if time allowed) at the same time as their degree studies.

So far we have been thinking of the highest products of the mathematical tripos, the men capable of adding to our store of knowledge by original work. We must also think of the general mass of the graduates and consider whether the present arrangements are the best possible for them. Let us imagine the change made in 1882 to be carried to its natural conclusion, so that the mechanics and the fragmentary physics are cut out of the tripos and the study reduced to pure mathematics. We shall then have a body of men in possession of a tool on the fashioning of which they have spent three solid years, and yet to whom no material has been supplied upon which to use the tool so elaborately prepared. Could any education be worse? It is true that few of them will make direct use of the tool in after-life, that the thing of value to them is a training that will fit them to do good work in other spheres. But to be effective, such training by means of this tool must include the use as well as the fashioning of the tool. This picture is of course worse than the reality, since the tripos includes mechanics as material to which the students may apply their mathematics, but this range of use is too limited to secure effective training.

Fortunately there is ready to hand a means of broadening the training given by the mathematical tripos. Physics provides a great variety of material for the working up of which the mathematical tool is required, and if that subject (studied from a suitable angle) is included, the student's training gains enormously in value. The situation at Cambridge is not without hope. There was a time when the mechanics and physics of the tripos were no more than pegs on which to hang pieces of mathematical manipulation, but now the regulations require that students should show a knowledge of physical phenomena and not merely of analytical developments. We may hope that as this attitude towards physics gains strength, a course of study will be developed in which, without overloading the tripos, suitable mathematical and physical studies will be carried on in harmonious proportion.

To this discussion of the universities a few words must be added about the schools. In order that a proper balance between the two sides of the university studies of the mathematician may exist, it is important that the balance should be maintained in the schools also. On this the authorities differ. The Board of Education, it is pleasant to see, in its regulations for advanced courses in secondary schools, requires the mathematical pupil to take up a science in addition. On the other hand, seven of the eight bodies that conduct Higher Certificate Examinations allow candidates to appear with mathematics as their sole group subject, and only the Northern Universities Joint Matriculation Board requires the mathematical candidate to take up a science also as a group subject. It is, of course, true that in addition to his group subject of mathematics a candidate is required by these seven examining bodies to offer one subsidiary subject chosen from a list of about twenty. Physics is one of the list of twenty subjects, and by choosing it the student can do a little towards redressing the balance; but the balance remains far from true, and the matter is too important to be left to his choice. If the conclusions of this article are sound, the mathematical candidate for the Higher Certificate ought to be required to take both mathematics and physics as group subjects. Appropriate pruning of both the subjects will make this possible without overloading the course and without stunting his mathematical growth.

In the Secondary School Examinations Council which the Board of Education has set up for the control and guidance of examining bodies, there exists the germ of the promise of better things. When this council gets into its stride it is possible that it may take a hand in this question of the proper education of the mathematician and the regulations of these seven examining bodies.

Theories of Evolution and their Application to Human Affairs.

Studies in Evolution and Eugenics. By Prof. S. J. Holmes. Pp. v+261. (New York: Harcourt, Brace and Co., 1923.) n.p.

PROF. HOLMES'S book consists of a collection of essays on evolutionary theories and their application to human affairs, several of which originally appeared in certain American monthly magazines. The chapters on evolution are chiefly valuable as reflecting the currents of opinion which are passing in the minds of American biologists at the present time. They do not contain any thorough and critical analysis of the subject, nor do they recognise the importance of recent experimental work. But it is of interest to notice that Prof. Holmes sees clearly that "natural selection" cannot be a final explanation of evolution. Natural selection undoubtedly works, but there is a "beyond" which is unexplained, namely, the cause of the variations on which it works. Prof. Holmes rejects the Lamarckian explanation on the ground that "the majority of biologists are not Lamarckists." He seems unaware that the essential point in the Lamarckian theory has been experimentally demonstrated by three different observers, namely, Kammerer in Vienna, Durkhem in Breslau, and Pavlov in Moscow, whilst his own countrymen, Guyer and Smith, have furnished proof that an alteration in a bodily organ can effect a corresponding change in the germ cell, which is the basis of Lamarckism. It is true that Prof. Carr-Saunders and Mr. J. S. Huxley attempted to repeat Guyer and Smith's experiments and obtained a negative result, and founding on this have explained Guyer and Smith's results as due to chance. But Prof. Carr-Saunders and Mr. Huxley *varied the conditions of the experiment,* and their confident negation appears rather foolish in the light of renewed researches by Guyer and Smith on fresh material, in which they not only confirm all their previous discoveries, but also considerably extend them. The scepticism of biologists on the Lamarckian question is entirely due to their neglect patiently and thoroughly to make themselves acquainted with the work that has been done on the subject.

In considering the problem of the origin of several species from one original species, Prof. Holmes recognises that isolation plays a definite part. He agrees that the law formulated by his countryman Jordan is generally true, namely, that the nearest allies of any given species are not found in its vicinity but in a distant part of the earth. But he complains that the law encounters many exceptions. Allied species often live side by side and yet refuse to interbreed, and he states that it is coming to be recognised that the marks which distinguish species are usually not of any value to their possessors. Now in our opinion these scruples of Prof. Holmes are not justified. The key to the solution of the problem of the origin of species lies in the study of the local races of wide-ranging species. All such species, except those, like the eels, which migrate from all parts of the world to a common spawning place, are broken up into a number of such races, and the differences between these must be explained as the consequences of the reactions of the constitutions of the members of the species to the different environments to which they are exposed. That Prof. Holmes is unable to explain the exact "use" of a particular patch of pigment or of a tuft of hairs is entirely beside the point: the animal survives as a result of all its activities, and an apparently useless feature may be "the outward and visible sign of an inner physiological grace."

So-called allied species which live near each other are not really closely allied. In the group in which we are especially interested (Echinodermata) two species of star-fish, *Asterias glacialis* and *Asterias rubens,* live in the English Channel; but the nearest ally of *A. rubens* is *A. vulgaris* from the eastern coast of North America. Similarly there exist two types of sea-urchin in our British waters, the large rosy *Echinus esculentus* and the small green *Echinus miliaris,* but the nearest ally of *E. miliaris* is not *E. esculentus* but *E. microtuberculatus* from the Mediterranean. But once we look for them, cases like this meet us in all divisions of the animal kingdom. The herring-gull (*Larus argentatus*) and the black-headed gull (*Larus ridibundus*) are two very similar birds, and may be seen flying together on the Cornish coast, but the closest allies of *Larus ridibundus* are the black-headed gulls of N. America. Then there is the extraordinary case of the skink lizard, *Chalcides oallatus,* described by Mr. E. G. Boulenger. This species ranges from Morocco round the northern border of the Sahara to Somaliland: in the west it is a comparatively short animal with stout legs, in the east it has become a long sinuous creature with feeble limbs, evidently on its way to becoming a snake, yet the change is continuous as we pass from one end of the range to the other. If this species were broken into sections by changes in land and sea, its different fractions would undoubtedly take rank as distinct species.

The disappearance of useless organs has always presented difficulties to those who rely on natural selection as the sole factor in evolution. That "flower of speech," panmixia, was invented to get over the difficulty of supposing that a slight variation in the size of a disappearing organ would determine the survival of its possessor. Panmixia asserted that every organ of the body was only kept up to its normal development by the weeding out of all the unfortunate individuals in whom it was imperfectly developed, and consequently when this selection was no longer operative, and individuals with the organ poorly developed survived, the average size of the organ would undergo rapid diminution.

Prof. Holmes formally rejects panmixia, because he says that recent investigation has shown that small plus or minus variations in the size of an organ are environmental and not inherited, but he eventually puts forward a theory which in its essence is identical with panmixia. He notes quite correctly that the vast majority of the "mutations" encountered by Morgan and other geneticists are "failures from the point of view of adaptation," and that when these failures are no longer eliminated they gradually reduce the size of the organ. The vastly simpler explanation that the loss of function gradually suppresses the organ is not accepted by him, though this explanation was adopted by Darwin. There is one critical case, however, which shows that this is really the true explanation. The blind Proteus of the caves of Carniola has the merest vestige of an eye—a small pigmented sac sunk deep under the skin without lens or cornea. If we followed Prof. Holmes we might have suggested that degenerative mutations of the "genes" governing the eye-structure of this newt had appeared and had not been eliminated since the animal, living in darkness, no longer uses its eye. But if a young Proteus be exposed at intervals to the action of red light, the rudiment of the eye will develop into a perfect organ capable of vision, with well-developed lens, retina, cornea. Such wonderful creatures were exhibited at the Linnean Society last year by Dr. Kammerer. What has become of the supposed "degenerative mutations" in this case?

That, indeed, all the mutations with which Mendelians experiment are of a pathological character, and result from a weakening or breaking down of that regulation which binds together the organs of an animal into a functional unity, is becoming every day clearer to systematists, palæontologists, and embryologists. Prof. Holmes quotes an admission by Morgan that the mutations with which the geneticist deals have rarely if ever found the distinctive marks of species, but Morgan asserts that minute mutations occur in the same circumstances and are inherited according to the same rules as the larger ones: yet this assertion is just what the pure-line investigations seem to contradict. Prof. Holmes makes further the just remark that "mutations" are "organismal," by which he means that each affects in greater or less degree every organ of the body, since it is a change in the general constitution of the animal. We may add that Tornier has given an explanation of the physiological nature of this change which we commend to Prof. Holmes; it is a *germ-weakening* or lessening of the vital energy of the germ-cell, which results in disturbances of the harmony of the development of the organs. When the cause underlying the geneticist's mutations has become more widely known, it will be recognised that they are *ipso facto* ruled out as having played any part in evolution, since such weakened individuals would have no chance in struggle for existence.

When Prof. Holmes turns to consider the bearing of the theories of evolution on the prospects of the human race, he sorrowfully recognises under the title of our "deteriorating inheritance" the fact that the lower and less worthy elements of the population marry early and breed recklessly, whilst the more desirable elements postpone marriage for prudential reasons, and consequently, quite independently of birth-control which they usually practise, have few children. But though he recognises this, Prof. Holmes shrinks from the deduction drawn by Spencer that philanthropic efforts to ameliorate the lot of the unfortunate and prevent their elimination have a deleterious effect on the race. His reasons for differing from Spencer are not very convincing. He thinks that if wealth were more evenly distributed, this would of itself induce the lower strata to limit their families; but this begs the question. It is arguable that the "lowness" of the stratum into which a man sinks is the consequence rather than the cause of his tendency to reckless reproduction, and undoubtedly this tendency is strongly marked in certain races, such as the Poles and the Southern Irish. Prof. Holmes also suggests that when the struggle for existence is severe it may result not in the elimination of the unfit, but in the survival of sickly, stunted people.

There are, however, certain ominous facts which throw doubt on this conclusion. We possess a record of the condition of affairs in Bethnal Green eighty years ago. Then there were no drains, and the only supply of water was from wells. All the filth and rubbish was flung into the street and raked into dung-heaps, which were only cleared away at long intervals by decrepit old men. Then as now the neighbourhood was inhabited by the working-class, and large families were the rule. The death-rate was appalling, but the survivors were noted for their extraordinary vigour and their "savage energy" in industry. All our elaborate sanitary improvements and "Poplarism" have only enabled a weakened and incapable type of people to survive. Prof. Holmes objects to birth-control, because only the prudent would practise it: this is true, but what he fails to recognise is that many of the prudent and intellectual classes use birth-control now; so far as they are concerned the mischief is already done. The advocates of birth-control desire to teach it to the working-class, the best of whom are only too desirous of learning the means of employing it. If this end were accomplished, the lowest stratum of utterly reckless and vicious people would no doubt be unaffected, but a strong public opinion would have been created which would support the application to these people of the only remedy possible (namely, sterilisation).

On the question of race mixture, Prof. Holmes has some very interesting facts to communicate. It appears that among negro women a man with some proportion of white blood is preferred to the pure negro, and in this way the whole negro population of America is becoming infiltrated with white blood. Further, only the mulatto migrates in order to better his economic condition: the pure negro has all the immobility of primitive races. Notwithstanding their early marriages and large families, the negroes are not increasing relatively to the whites: the race is indeed slowly dying out owing chiefly to its infection by "civilised diseases," just as has happened to other backward races brought into contact with the white race.

Prof. Holmes, like many of his more thoughtful countrymen, is very doubtful about the results of the policy of unrestricted immigration which America has pursued for the past century. He points out with great force that America's primary duty is to care for her own welfare; "humanity" in the abstract has no claims on her, and a country should concern itself before all things with the quality of its future citizens.

In conclusion, we commend this book as a series of most stimulating and thoughtful essays to readers of NATURE. Though we differ from Prof. Holmes on many points of evolutionary theory, we think that America is to be congratulated on having authors like him who spread a knowledge of the laws of biology amongst the mass of the people, and in the general diffusion of this knowledge the United States are far ahead of Great Britain. E. W. MACBRIDE.

Soap in Practice and Theory.

(1) *The Modern Soap and Detergent Industry, including Glycerol Manufacture.* By Dr. Geoffrey Martin. Vol. 1: Theory and Practice of Soap Making. Pp. xii+71+36+34+53+13+96+64. (London: Crosby Lockwood and Son, 1924.) 36*s.* net.

(2) *Fats: Natural and Synthetic.* By Dr. W. W. Myddleton and T. Hedley Barry. Pp. xi+182. (London: Ernest Benn, Ltd., 1924.) 25*s.* net.

THE two works under notice both deal with the same branch of technical chemistry and presumably represent typical examples of the modern method of treatment of the application of chemistry and chemical engineering in industry. It is permissible, and perhaps of value, to examine them critically from the somewhat diverse points of view both of the chemist and the industrialist.

(1) Dr. Martin's book compels admiration from the outset; conceived on the grand scale—it is the first of three volumes—it is obviously a work of reference which no soap works or technical soap maker will wish to be without. We would picture the author, after a lifelong experience in the industry, making the writing of this book the solace of his later years did we not believe that in point of actual fact his acquaintance with the practical side of the industry has at the best been but fleeting. The information provided has therefore been obtained at second-hand by the study of the literature and of manufacturers' catalogues. We hasten to add that this work has been well done, but the result is that the information supplied is undigested and that the reader has to sift it for himself. Exhaustive though the book is, there is other plant besides that which he describes, and though the pitfall of describing and figuring much that is obsolete has been avoided, the mere reproduction of plant catalogues has the disadvantage that it tends to ignore the weak points and exaggerate the merits of a machine.

The reader wants to find out these before and not after he has made the purchase—so sceptical has the manufacturer become to-day, perhaps as the result of experience, that he often expects a prolonged free trial of the plant before purchasing. We therefore reach the question, should technical text-books be written by an expert, with experience of the industry, even though this will leave him to some extent biassed, or should they be honest compilations of everything offered without criticism? We must leave the answer to the reader, though lest we should be considered unjust to Dr. Martin, we hasten to say we shall keep his book ourselves and, we hope, use it and advise our friends to do so likewise.

A brief outline of the scope of the work appears desirable. It commences with a section devoted to the nature of soap and of detergent action which is particularly well done and includes excellent summaries of modern work, in particular that of McBain and his school. Copious references are given to the literature, the value of which is much enhanced by a brief indication of the contents of each paper. The author exhibits a remarkable faculty for getting the essentials. The next two sections, dealing with the organic and inorganic raw materials used in the industry, are again characterised by their crispness and are equally good. That devoted to perfumes partakes of the nature of a catalogue but is not out of place. Section 6 gives a full and comprehensive account of the manufacture of soap, including practices current in America and on the Continent, both of which are in some respects different from those in Britain. It is clearly written, admirably illustrated, and as the author claims in his preface, marks a great advance on anything previously done. The final section is devoted to the special consideration of household and laundry soaps. The book is otherwise so well produced that the lack of an index is noticeable—the sections are paged independently.

(2) One's opinion of the work by Messrs. Myddleton and Barry is influenced from the start by the delightful way in which it is printed, illustrated and bound. After all, why should art and literature have the monopoly of nice books? May not science also look forward to special editions de luxe of its text-books numbered and signed, with perhaps a Pennell drawing as a frontispiece?

This book is more chemical, and therefore less "applied" to practice, in its scope: in comparison with Dr. Martin's, it suffers from being more diffuse and in using the language of the laboratory where often that of the workshop would suffice. It is wider in its scope, including other uses of oils and fats besides that of soap-making. After preliminary information relating to the fatty acids, a chapter is devoted to oil extraction and purification which covers the ground in a satisfactory and up-to-date manner, indicating principles rather than details. The fatty acid industry next comes under review, an account being given of the various splitting agents including enzymes. Inasmuch as in practice these processes are in the main applied to low-grade fats, and are used in small works, much of the current information is conflicting and unsatisfactory: this is reflected in the chapter.

In dealing with catalytic hydrogenation, to which subject the authors are evidently specially attracted, they are on more difficult ground—so much of the information available to the public is contained in the patent literature, and therefore characterised by its optimism rather than by its practical accuracy. In this respect the chapter requires reading with caution. The methods of physical and chemical examination of oils and fats, including hydrogenated products, are detailed at a length—28 pages—somewhat excessive in proportion to the general treatment of the subject. Though valuable, this is not either so novel or original as the authors would seem to indicate.

The chapter on the theory of soap manufacture is good in parts, but incomplete without a full abstract of McBain's researches, which, whether they prove ultimately to be right or wrong, are quite the most stimulating and suggestive contributions of late years. The chapter on edible fat discusses in the main the application of substitutes, and is followed by an account of a continuous process of hydrogenation, which has apparently the effect of lessening the production of what the authors term the "new acids of hydrogenation." Progress no doubt lies in this direction, but the problem is far from solved, and in this section the authors appear to wander from acting as authorities to becoming advocates. The closing pages are likewise less satisfactory or even misleading in regard to accuracy. We regard this book as of definite value to the chemist who has sufficient knowledge to read it critically: it is scarcely suitable for the works technologist.

The scope of the two books outlined somewhat at length in the foregoing shows how complex a modern technical undertaking, such as soap-making, has become. Highly skilled chemists are required to elucidate the theory of the processes, other chemists to control them in operation and to watch unceasingly the purity of the raw materials and finished products. The chemical engineer, if there be such a man, designs the plant in which the chemical operations are performed, but becomes himself again in dealing with the automatic stamping, packing, and conveying machinery so essential to mass production in a big works. The process manager not only keeps the wheels of production turning, be the load great or small, watches the maintenance of quality, the keystone of the arch of success; he studies always the all-important factor of cost of production. Science is a great factor in a works—quality and cost are greater—and all three must run in harmony for success. E. F. A.

Birkbeck College.

A Short History of Birkbeck College (University of London). By C. Delisle Burns. Pp. 170 + 8 plates. (London: University of London Press, Ltd., 1924.) 5*s*. net.

THIS book is a centenary record of the fortunes of Birkbeck College from its foundation in 1823. For its purpose it is excellently done, well planned and well turned out. From a mass of rather intractable material Mr. Burns has picked what he found to be the essential things, among them a few *personalia* which gleam in the drab heap of administrative detail. But, while not failing in his duty as chronicler of constitutional changes, he has succeeded in the more difficult task of painting the portrait of an institution. It is the portrait of a sturdy English enterprise—one of the English reactions to Scottish stimulus—which began with a vague yet wholesome mixture of public spirit, philanthropy, and political instinct, and was fundamentally collegiate from the first, though for a long time incapable of putting into words the real purpose which bound its members into a society. Its lot fell in an age of opportunity, which was also what Mr. Wells calls an age of confusion. The countenance of Birkbeck College is consequently like that of a man of vigorous character and benevolent nature who has been worried by many intrusive conflicts of principle and has been forced into a good deal of honest opportunism in the long search for a clear expression of his instinctive purpose.

The instinct of those who in three generations have prevailed in the policy of Birkbeck College was to combine freedom of educational initiative with the obedience necessary to any ordered system of education in the State. This instinct rejects pure voluntaryism as inadequate and evanescent. On the other hand, it repels Government monopoly of educational control as restrictive and doctrinaire. It seeks some sort of union between the responsibility of groups and the authority of the State. Its ideal is a balance of power. Its policy is incessant readjustment of opposite forces. Its instrument is the chartered guild or college, because only in college or guild can it find a unit which is both stable and sufficiently free.

The function of Birkbeck College has been to establish the right of part-time students to enjoy opportunities for higher education. Academic bodies, whether self-governing or under the direction of the State, are prone to shut out from the privileged ranks of master-craftsmen in arts or science all who have not passed through a long apprenticeship. Birkbeck College, and other institutions of the same family, stand for dilution. They contend that among those who are earning their living while their contemporaries have leisure for a full-time training there are some who, by industry and talent and with the help (as Lord Haldane points out in his introduction) of the informal education of the work-a-day world, can make good under any reasonable test of mental power and attainment. For these exceptions to a rule which is in general wise, they ask for special consideration. They urge that by-students of merit should have a by-pass to the ordinary tests for a degree, and by implication to the practice of any profession for which in common practice a degree is a prescribed or customary condition.

Birkbeck College has had a hard struggle to survive. For more than sixty years it was embarrassed by want of necessary funds. Nearly a century had to pass before it was financially safe. Only in a large city, and in London for choice, could it have found the clientele which enabled it to cling to life. Records of the after-careers of the students it has encouraged would prove, if further proof were needed, the national importance of its work. But the names of Sidney Gilchrist Thomas the technologist, of Mr. Ramsay MacDonald and Mr. Sidney Webb, of Mrs. Besant, Sir Arthur Pinero, and Mr. Pett Ridge are outstanding examples of talents which the College has helped to brilliant use.

Not the least of the merits of Mr. Burns's book is the just tribute which it pays to the succession of able men who served the College in the different stages of its hazardous adventure. Thomas Hodgskin and J. C. Robertson appealed for its foundation a hundred years ago. George Birkbeck, the Yorkshireman of Quaker parentage, then a physician in London, responded to their appeal, from memories of his experience in teaching mechanics in Glasgow more than twenty years before. In the early 'sixties, when the institution was beginning to recover from the decay of its first constituency, George Norris, then an official in the Education Department, Francis Ravenscroft, and J. C. N. White put it on its legs again by insisting on a more adequate supply of educational classes, the demand for which had been stimulated by the examinations opened at the University of London. And in the last chapter of its history, Mr. George Armitage Smith, its wise and indefatigable principal from 1896 to 1918, was the general who in the teeth of many difficulties won the battle for University recognition and so brought the College into port.

Our Bookshelf.

Advanced Vector Analysis: with Application to Mathematical Physics. By Dr. C. E. Weatherburn. (Bell's Mathematical Series: Advanced section.) Pp. xvi+222. (London: G. Bell and Sons, Ltd., 1924.) 15*s.* net.

The term "vector" is used to include two distinct classes of geometrical and physical entities. A *polar* vector, typified by a displacement or a mechanical force, is a magnitude associated with a certain linear direction. The members of the second class, that of *axial* vectors, are primarily not vectors at all. An axial vector, exemplified by a statical couple, is a magnitude associated with a closed contour lying in any one of a system of parallel planes. Two *senses* of direction are distinguished, both for polar and axial vectors.

The methods of vector analysis are chiefly used as a means of condensed expression of various important relations which frequently occur in mathematical physics. In his elementary volume, Prof. Weatherburn dealt with vector algebra and differentiation with respect to one scalar variable, showing how vectors may be usefully applied to geometry and mechanics. The volume now noticed begins with partial differentiation of a vector-function of several variables and introduces right at the outset the gradient of a scalar point-function and the divergence and curl of a vector-function. Four chapters are given to the machinery of vector-analysis and the rest of the book contains a fairly complete introduction to mathematical physics. The subjects treated include, so far as vector analysis bears on them, potential theory, conduction of heat, hydrodynamics of both frictionless and viscous fluids, theory of central quadric surfaces, statical strains and stresses, and electricity and magnetism. Naturally, many students of applied mathematics will only be interested in one or two of these sections. The final chapter, on the Lorentz-Einstein transformation and relativity, is, to a reader acquainted with the methods of vector analysis, much more illuminating than most recent semi-popular expositions of this subject.

W. E. H. B.

A List of Official Chemical Appointments, compiled, by direction of the Council of the Institute of Chemistry and under the supervision of the Publications Committee, by the Registrar of the Institute. Fifth edition, revised and enlarged. Pp. 311. (London: Institute of Chemistry, 1924.) n.p.

THIS is the fifth edition, on the same general lines as previously, of the well-known publication issued by the Institute of Chemistry, with the primary object of providing a list of official chemical appointments in Great Britain and the Colonies. The previous edition was published so far back as February 1912, the production of the present and now up-to-date publication having been delayed by the War.

The list includes in great detail all the professional and teaching appointments relating to chemistry in the service of the government, county and borough councils, universities, colleges, technical institutions, medical, agricultural, and veterinary colleges, public and secondary schools, and the book is obviously invaluable for reference purposes. Further, there is a list of chemical and allied societies.

The Institute of Chemistry, as expressed in the preface, is optimistic concerning the increased demand for chemists in government and municipal administration, but it seems to us that further opportunities for industrial chemists would be much more important, especially in view of the scores of chemists out of work and the hundreds that continue to be turned out by the Universities.

Calculus for Schools. By R. C. Fawdry and C. V. Durell. Pp. viii + 300 + xx. (London: E. Arnold and Co., 1923.) 6*s*. 6*d*. net.

MESSRS. FAWDRY and DURELL have written a book eminently suitable for the class of pupil they have in mind. It contains a very good course, and has one advantage over some other books in that an attempt is made to deal with the exponential and logarithmic functions in a manner that the student might really understand. The emphasis laid on the *practical* convenience of the logarithms to base e is misleading; it is rather theoretical convenience that dictates the use of base e. Also, one cannot help wondering whether any pupil is ever impressed by such an example as finding the limit of $(x^2-4)/(x-2)$ as $x \to 2$: if so, he must be a particularly innocent pupil who takes a delight in thinking as he is told. Ex. 13 on p. 47 would perhaps amaze an architect, and there is a bad misprint on p. 168. Further, is it really essential to say that the value 2·30 for $\log_e 10$ leads to 0·435 for $\log_{10} e$? There is danger that the student may thus learn something that he will have to unlearn with much heart-burning later on. There is a bad misprint on p. 195. But these small faults do not detract from the value of the book, which we can heartily recommend.

Index to Volumes 1-50 (1872–1921) "Indian Antiquary." Compiled by Lavinia Mary Anstey. Part 1: Authors' Index. Pp. ii + 50. 2 rupees to subscribers to the *Indian Antiquary*; 4 rupees to non-subscribers. Part 2: Subject Index; Part 3: Illustrations. Pp. ii + 88 + ii + 10. 4 rupees to subscribers to the *Indian Antiquary*; 5 rupees to non-subscribers. (Bombay: British India Press, Mazgaon; London: Bernard Quaritch, Ltd., n.d.)

THE *Indian Antiquary* was founded in 1872 by Dr. James Burgess, who acted as editor until it was taken over in 1885 by Dr. J. F. Fleet and Sir (then Captain) Richard C. Temple. The latter has thus been editor for more than thirty-seven years. The completion of the fiftieth year of issue in 1921 has been marked by the publication of an index of the whole compiled by Miss L. M. Anstey, to whom the thanks of all students of things Indian are due. The *Indian Antiquary* has covered a wide field, and this index will prove invaluable to future research in the epigraphy, history, and anthropology of India.

The author-index includes all the most distinguished names in Indian studies during the last half-century; while the subject index, especially in the list of books reviewed, might well be held to constitute a survey of progress in these studies during that period. The entries relating to inscriptions, and the eras and dynasties with which they are concerned, will be found especially valuable. Miss Anstey has carried out a laborious task with marked success.

Clouds and Smokes: the Properties of Disperse Systems in Gases and their Practical Applications. By Dr. William E. Gibbs. (Text-Books of Chemical Research and Engineering.) Pp. xiii + 240. (London: J. and A. Churchill, 1923.) 10*s*. 6*d*. net.

IN a foreword to this monograph on "Clouds and Smokes," Sir Oliver Lodge directs attention to this "rather out-of-the-way subject, which, nevertheless, is of considerable practical importance." The reviewer would emphasise not only the vital importance of the subject, but also the commendation given of the way in which Dr. Gibbs has carried out his task. Few people have given to the question of dust in air the attention it deserves, and it may be well to recall the pioneer work carried out by Dr. John Aitken and by Sir Oliver Lodge himself.

Letters to the Editor.

[The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, nor to correspond with the writers of, rejected manuscripts intended for this or any other part of NATURE. *No notice is taken of anonymous communications.]*

The Law of Dispersion and Bohr's Theory of Spectra.

IT is well known that a consistent description of the phenomena of dispersion, reflection, and scattering of electromagnetic waves by material media can be given on the fundamental assumption that an atom, when exposed to radiation, becomes a source of secondary spherical wavelets, which are coherent with the incident waves. If we imagine that the incident radiation consists of a train of polarised harmonic waves of frequency ν, the electric vector of which at the point in space where the atom is situated at rest can be represented by

$$\mathfrak{E} = Ev \cos 2\pi\nu t, \quad . \quad . \quad . \quad . \quad (1)$$

where E is the amplitude and v is a unit vector; the secondary wavelets can be described as originating from a varying electrical doublet, the strength of which is given by

$$\mathfrak{P} = Pw \cos (2\pi\nu t - \phi), \quad . \quad . \quad . \quad . \quad (2)$$

where P is the amplitude and w also a unit vector, while ϕ represents the phase difference between the secondary and primary waves. The quantities P, w, and ϕ depend on v, ν, and on the peculiarities of the atom; moreover, the amplitude P will be proportional to the amplitude E of the incident waves.

If we consider an atom containing an electron of charge $-e$ and mass m, which is isotropically bound to a position of equilibrium, we find on the classical theory that the vectors v and w will coincide and the following expression for P is found to hold for frequencies which differ sensibly from the natural frequency ν_1 of the electron.

$$P = E\frac{e^2}{m}\frac{1}{4\pi^2(\nu_1^2 - \nu^2)}. \quad . \quad . \quad . \quad (3)$$

In the region where this formula holds the phase difference ϕ is very small and of such a magnitude as to ensure energy-balance. For substances exhibiting absorption lines at the frequencies $\nu_1, \nu_2 \ldots \nu_i$, a formula of the type

$$P = E\sum_i f_i \frac{e^2}{m}\frac{1}{4\pi^2(\nu_i^2 - \nu^2)}, \quad . \quad . \quad . \quad (4)$$

where the quantities f_i are constants, has actually been found to represent the results of experiment with considerable accuracy. Especially the experiments of Wood and Bevan on the dispersion of light in monatomic vapours of alkali metals have confirmed formula (4) and allowed a determination of the constants f_i which are conjugated to the different absorption lines of the vapour.

In Bohr's theory of spectra, the picture of electrons which are elastically bound inside the atom is abandoned, and for it is substituted a picture according to which an atom exhibiting an absorption line of frequency ν is capable of performing under the influence of the illumination a transition from the state under consideration to a stationary state the energy content of which is $h\nu$ greater. On Bohr's principle of correspondence, the possibility for such transitions is considered as being directly connected with the periodicity properties of the motion of the atom, in such a way that every possible transition between two stationary states is conjugated with a certain harmonic oscillating component in the motion.

In a paper by Bohr, Slater, and the writer, which gives a more detailed discussion of an idea briefly described by Dr. Slater in a recent letter to NATURE (March 1, p. 307), and is to appear shortly in the *Philosophical Magazine*, it will be shown that, with the correspondence principle as a guide, it seems possible to arrive at an adequate description of the activity of the atoms regarding their interaction with radiation. On this theory the picture described above of the mechanism underlying dispersion and scattering phenomena is essentially preserved, and the important question arises concerning the quantitative laws connecting the quantities P, w, and ϕ appearing in (2), which characterise the reaction of an atom in a given state against external radiation, with the peculiarities of the transitions which the atom may perform to other stationary states. The present state of the quantum theory does not allow a rigorous deduction of these laws. It is, however, possible to establish a very simple expression for P, which fulfils the condition, claimed by the correspondence principle, that, in the region where successive stationary states of an atom differ only comparatively little from each other, the interaction between the atom and the field of radiation tends to coincide with the interaction to be expected on the classical theory of electrons.

Consider an atom in a stationary state which by absorption of radiation of frequencies $\nu_1^a, \nu_2^a, \ldots$ may perform transitions to states of higher energy, and by emission of radiation of frequencies ν_1^e, ν_2^e may perform spontaneous transitions to states of lower energy. We will, following Einstein, denote the probability of the isolated atom performing in unit time one of the latter transitions by $A_1^e, A_2^e, \ldots$ whereas the analogous probability coefficients for the spontaneous transitions of which the state under consideration represents the final state are denoted by $A_1^a, A_2^a, \ldots$ For the sake of simplicity we will further assume that the statistical weights of all the states involved are the same, and that the atom is so oriented in space that the electrical vector in the spontaneous radiation conjugated with the different transitions under consideration is always parallel to the electrical vector of the incident waves. The expression for P alluded to above takes, then, the following form:

$$P = E\sum_i A_i^a \tau_i^a \frac{e^2}{m}\frac{1}{4\pi^2(\nu_i^{a2} - \nu^2)} - E\sum_j A_j^e \tau_j^e \frac{e^2}{m}\frac{1}{4\pi^2(\nu_j^{e2} - \nu^2)}, \quad (5)$$

where $\tau_i^a = \frac{3mc^3}{8\pi^2 e^2 \nu_i^{a2}}$ and $\tau_j^e = \frac{3mc^3}{8\pi^2 e^2 \nu_j^{e2}}$ represent the time in which on the classical theory the energy of a particle of charge e and mass m performing linear harmonic oscillations of frequency ν is reduced to $1/\epsilon$ of its original value, where ϵ is the base of the natural logarithms. In analogy with the region of applicability of formula (3), this formula only applies in the regions for ν which lie outside the absorption and the emission lines, where the phase angle ϕ is negligibly small.

The reaction of the atom against the incident radiation can thus formally be compared with the action of a set of virtual harmonic oscillators inside the atom, conjugated with the different possible transitions to other stationary states. These oscillators might be thought of as electrical particles with such charge e^* and mass m^* that the classical formula (3) would give the right result directly, but if we do so, we meet with the remarkable circumstance that, while for the "absorption oscillators" $\frac{e^{*2}}{m^*} = A_i^a \tau_i^a \frac{e^2}{m}$ is a positive quantity, the corresponding expression for the "emission oscillators" $\frac{e^{*2}}{m^*} = -A_i^e \tau_i^e \frac{e^2}{m}$ becomes negative. Denoting the quantity $A\tau$ which thus can be conjugated with a given transition and has the dimensions of a number, by f, one might introduce the following terminology: in the final state of the transition the atom acts as a "positive virtual oscillator" of relative strength $+f$; in the initial state it acts as a negative virtual oscillator of strength $-f$. However unfamiliar this "negative dispersion" might appear from the point of view of the classical theory, it may be noted that it exhibits a close analogy with the "negative absorption" which was introduced by Einstein, in order to account for the law of temperature radiation on the basis of the quantum theory.

Led by considerations of the close connexion between dispersion and selective absorption, Ladenburg has proposed a formula equivalent to ours if the second term on the right side is omitted. In the case where the dispersing atoms are present in the normal states and only positive oscillators come into play, his formula is thus equivalent to ours. In the general case of a stationary state where the atom can perform spontaneous transitions to states with lower energy, negative virtual oscillators also come into play, corresponding to the second term in our formula.

As shown by Ladenburg, there is considerable experimental evidence in favour of the connexion between selective absorption and dispersion as indicated by the formula when applied to atoms in their normal state. The experiments at hand scarcely allow testing the complete formula in a more general case. It may be remembered, however, that the presence of the second term in (5) is necessary if the classical theory can be applied in the limiting region where the motions in successive stationary states differ only by small amounts from each other. H. A. KRAMERS.

Institute for Theoretical Physics,
Copenhagen, March 25.

Sunshine and Health in Different Lands.

MAY I ask the courtesy of your columns to make the following remarks in connexion with the letter on the above subject by Mr. L. C. W. Bonacina which appeared in NATURE of April 5?

Mr. Bonacina says: "We are insistently being told that direct sunshine exerts a powerful destructive effect upon germs of disease . . . the fact must be co-ordinated with another fact, namely, that it is precisely in hot sunny climates that many species of pathogenic organism acquire such deadly virulence," etc. But is not this rank exuberance of life due to the high relative humidity associated with the insolation, for the driest regions are the healthiest, at least for Europeans? The chief disadvantage of the large insolation appears to be the liability to heat-stroke.

As regards the insolation of the polar regions, surely the testimony of explorers is that the lack of light in the winter is one of its most trying features.

Excessive insolation may have its disadvantages, and in all probability it is undesirable to take the question of sunlight apart from other climatic features; but surely the results obtained by Sir H. Gauvain and others by the use of sunlight in the treatment of disease prove the advantages thereof. Mr. Bonacina's remarks on light-starvation in cities in winter owing to smoke are true enough; but here, too, this factor of smoke acts, in industrial districts at least, in summer. CICELY M. BOTLEY.

10 Wellington Road, Hastings,
April 16.

I AM indebted to the editor for the opportunity to reply at once to Miss Botley's comments on my letter to NATURE of April 5. It would, indeed, be "undesirable to take the question of sunlight apart from other climatic effects." The whole purpose of my letter was to express a warning against one-sided statements of a many-sided case, and to suggest that if combined efforts were made to discover how different countries compare with an optimum allowance of sunshine, if possible, to be evaluated, the local problems of sunshine therapeutics would be greatly clarified. Apparently there is, or used to be, a belief in India, the Philippines, and other tropical lands, that excessive stimulation by the ultra-violet rays of the sun should be specially guarded against by suitably-coloured clothing, and this in itself would raise the question of an optimum, and of the need of investigating the subject in its geographical relationships, in view of recent pronouncements upon the therapeutic importance of ultra-violet light in temperate latitudes.

Then as to the point raised about tropical humidity, it must be remembered that the constant combination of heat and moisture, denoted by the high wet-bulb thermometer, about 80° F., in regions like the Gold Coast, which is so debilitating, and also particularly favourable to the parasitic enemies of man, is itself a meteorological adjustment to fierce tropical insolation. Although as an adversary of insect life drought is no match for the frost of cold countries, the dry parts of the tropics are certainly more wholesome wherever the temperature is moderate; but these are just the parts where, on account of the scarcity of cloud and rain, the extremes of heat are encountered, as, for example, at Khartoum, where, for at least half the year, the temperature of the air by day soars much above blood-heat, so that the cooling power of the atmosphere upon the body, according to the wet and dry kata thermometer, is very low and sometimes even negative. (See Sutton's "Climate of Khartoum," Cairo, 1923.)

With regard to the comment about an adverse effect of the polar winter darkness, the real point at issue is whether a lengthy periodic darkness under natural climatic conditions, counterbalanced by an equally long seasonal brightness, could be so pernicious to health as the chronic artificial loss and deterioration of sunlight in parts of Lancashire, Yorkshire, Glamorgan, and Staffordshire, which have become excessively industrialised at the high cost of the purity and beauty of climate and soil in so green a land as England. Questions of this kind are rendered extremely complex, because climate acts not only directly, but also indirectly through economic and social factors.

Lastly, concerning Miss Botley's point about loss of *summer* sunlight in smoky districts, this is scarcely, for various meteorological reasons, comparable with the winter loss, although the Black Country certainly does, even in summer, sometimes suffer days of indescribable gloom. It is known that in London, where there is little factory smoke, domestic smoke is the main cause of many artificially darkened days in winter, a source of atmospheric contamination largely absent in summer. But even if the same amount of smoke were discharged into the atmosphere in June as in December, certain physical and meteorological conditions associated with a high altitude of the sun would not permit so large a proportion of light to be cut off as when the sun is low down at midwinter. On all accounts, therefore, the winter solstice is the period of the year round which the smoke-problem is most serious, though fortunately the frequent stormy weather between November and February prevents very many actual smoke-fogs and hazes. It is also rather more serious round the spring equinox than the autumn equinox, because, though the sun's altitude is the same, the temperature is lower, thus favouring a greater production of domestic smoke. Statistics are published on the degree of smoke-pollution at different times of the year; but no one who from suburban heights has habitually compared the visibility across London with the contemporaneous visibility in the opposite direction towards the open country will be under any illusion as to the relative importance of the smoke-screen in the summer and winter months.

L. C. W. BONACINA.

27 Tanza Road, Hampstead, N.W.3,
April 21.

On the Application of Science to the Fishing Industry.

THE comments in NATURE of December 15, 1923, p. 872, on Prof. Stanley Gardiner's lecture on the above subject were read with interest. There is, indeed, much fault to be found with the operation of the fishing trade by any one of scientific training. In connexion with the statement that fishermen look askance at the mere mention of studying the plankton as a guide to placing fishing nets, however, it may be of interest to readers of NATURE to learn that plankton studies are rendering very material aid to the oyster industry in parts of the United States.

This industry, which yields approximately 16,000,000 dollars annually, is almost wholly dependent on the north-eastern Atlantic seaboard upon oyster seed collected on artificial cultch. In practice, oyster shells are usually employed for this purpose. The larvæ of the American oyster are pelagic for approximately two weeks, during which time they may be carried long distances by currents. It was shown by me in 1917 that the larvæ are not uniformly distributed in the water but are herded by slicks and eddies and by their own reactions into swarms. It was shown later by me, and by Churchill and Gutsell, of the U.S. Bureau of Fisheries, that the heaviest sets occur in those regions where the greatest numbers of swimming oyster larvæ are found to congregate.

It has been possible from examination of the water also to predict ten days in advance the date of an expected set with an error of less than thirty-six hours, thus serving as a guide to intensive last-minute shelling.

So far from being "left cold" by these findings, the oyster growers have been quick to seize upon this aid to their work, and they now actually demand this service from Federal and State governments. One of the larger planters of Long Island hired for two seasons a college student trained in this type of investigation, furnished him with microscope, pump, plankton net, and other necessary equipment, and employed his time during the oysters' breeding season in making tests on the private seed grounds of the company. The student in question has recently been taken into the company for full-time work, practical as well as scientific, throughout the entire year.

Some progress has been made in determining the probable fatness of oysters from a study of the food organisms present in the water. In the large oyster shipping centres, such as Delaware Bay, information of this nature is welcomed by the oyster growers even more than is knowledge of the distribution and age of the oyster larvæ. The chief difficulty in determining the abundance of food organisms in the water lies in the fact that about 80 per cent. of the oysters' food is composed of nannoplankton, the separation of which from water requires a high-speed electrically driven centrifuge, which cannot always be installed close enough to the oyster beds to carry on investigations. The point of interest, however, is that the oyster growers understand the relation between the abundance of food organisms in the water and the fatness of oysters, thus appreciating the importance of plankton studies.

I have not had much contact with commercial fishermen, but from my slight acquaintance with them I have become convinced that many fishermen look upon men of science interested in fisheries as primarily conservationists, who are seeking to curtail the exploitation of certain species of fish, and must therefore be regarded with suspicion. This same attitude, much intensified, exists among the native oystermen along parts of our coasts.

In conclusion, I desire to point to the very cordial reception by oyster growers accorded to my father, the late Dr. Julius Nelson, during his investigations of the oyster from 1888 to 1915 in the United States and in Canadian waters, and to the same spirit which I have met since 1915, as proof that among those who follow the sea for a livelihood there are some who can appreciate the contribution which a knowledge of the plankton may make to their calling.

THURLOW C. NELSON.

Rutgers College,
New Brunswick, N.J., U.S.A.
April 5.

Hymenolepis nana and *H. fraterna*.

JOYEUX, in 1920, after a survey of most of the evidence, arrived at the conclusion that *Hymenolepis nana* of man, and *H. fraterna* of rodents, though apparently indistinguishable in all characters, both of the adult worm and of the egg, are yet two distinct *physiological* species. More recently, however, two Japanese investigators, Saeki and Uchimura, have denied the validity of the experiments described by Joyeux, and affirm that it is possible to infect mice with *H. nana* eggs. The original papers of these two Japanese investigators not being easily accessible, and the brief abstracts available providing little or nothing of that detailed information which is so essential in these matters, I have recently been enabled, by the kind hospitality of Dr. A. Bettencourt, to re-examine the subject.

Briefly stated, I conveyed to Lisbon fifty-seven *Hymenolepis fraterna* free mice, thirty of which I have fed on fresh *H. nana* eggs obtained from the stools of infants in the hospital attached to the Instituto Camara Pestana, the remaining twenty-seven serving as controls. In the first batch of *H. nana* egg-fed mice, 2 were infected out of 10; in the second batch of 13, 4 were infected; and in the third batch of 7, one only was infected. Thus 23 per cent. of the mice were infected—a result which is satisfactory in view of the fact that all the mice were adults, and therefore largely refractory to infection. The twenty-seven control mice showed no signs of infection, and thus the possibility of accidental infection with *H. fraterna* is entirely excluded.

Saeki and Uchimura are therefore correct in their view that *H. nana* and *H. fraterna* are one and the same species (though the converse experiment of infecting monkeys or man with *H. fraterna* of mice and rats is still a desideratum), and doubtless man has become secondarily infected with a parasite which originally was associated with mice and rats alone.

Full details of the experiments referred to above will be published at an early date.

W. N. F. WOODLAND
(Helminthologist, Wellcome Bureau of Scientific Research).

Instituto Bacteriologico Camara Pestana,
Lisboa, April 24.

Problems of River Pollution.

THE need for research on the problems of river pollution in relation to fisheries, referred to by Dr. Orton and Prof. Lewis in NATURE of February 16, p. 236, has long been realised by those who are concerned with the welfare of the fisheries.

The Royal Commission on the Salmon Fisheries (1902) and the Departmental Committee upon Freshwater Fisheries of England and Wales (1920) both emphasised in their reports the need for experiment and research as a necessary preliminary to improvement. The Committee also pointed out that this country, in comparison with others, was singularly ill-equipped for the study of fresh-water life.

In relation to pollution, the Royal Commission on Sewage Disposal, 1915 (Ninth Report, Sect. 132), pointed out that it had repeatedly directed attention to the need for continuous and systematic research. Although its labours had extended over a period far exceeding the customary span of a temporary Commission, yet it had been unable to explore many fields known to require investigation.

Some progress has been made. The appointment of the Joint Sub-Committee on Road Tarring and Fisheries, the taking over by the Ministry of Agriculture and Fisheries of the Experimental Station at Alresford installed by the Committee, and the appointment of the Standing Committee upon Rivers Pollution and Fisheries, are instances of recognition by the Government of the need which exists.

There appears, however, to be little prospect that the Government will be able to do more in the immediate future than it is doing at present, considerations of economy being paramount. Considerations of this nature cut short the work of the Road Tarring Committee; have curtailed and stopped extension of the valuable work of the Scottish Fishery Board on salmon; and, combined with political changes, have interrupted an extensive scheme for biological research in Ireland. Owing to pressure upon the limited staff of the Ministry, arising from similar considerations, the final report of the Road Tarring Committee still remains unpublished.

The deputation on pollution received by the Minister of Agriculture and Fisheries in 1921 was informed by the Minister that if funds were required the fisheries must provide them, the Ministry could not do so. The work of the Standing Committee, the appointment of which followed that deputation, is accordingly unpaid.

Within the range of private effort, work of value has been done by private individuals, and early in 1921 the Salmon and Trout Association engaged Dr. W. Rushton as biologist to investigate fishery problems. Dr. Rushton's work since then has thrown light both on general principles and on specific problems; has demonstrated the demand which existed for work of the kind and the extent of the field to be covered, the variety of the subjects dealt with and the points made by your correspondents as to the need for co-operation of experts in different fields—hydrographers, biologists, and chemists, as your correspondents point out, to which may be added engineers on whom falls the work of giving practical effect to scientific conclusions.

It may be inferred that if the need which exists is to be more adequately met, this can only be done by private effort on the part of those interested. May it be suggested that the first step is to ascertain whether organisation of any kind is practicable, and that, as a first step to this end, a conference on the subject might produce useful results, and would, at any rate, enable the position to be defined. Such a conference could consider how far the practical needs of collection and tabulation of data from all sources, co-ordination of existing effort, organisation and extension in the future, and the provision of funds could be undertaken.

The appointment of the Standing Committee on Rivers Pollution resulted from a conference held in 1921 by the courtesy of the Fishmongers' Company at Fishmongers' Hall. Might not similar results of value accrue from such a conference as is suggested?

F. G. RICHMOND,
Secretary, Salmon and Trout Association.
Fishmongers' Hall, London, E.C.4,
April 17.

The Possible Existence of a Growth-regulating Substance in Termites.

A LARGE number of insects of various orders which inhabit the nests of termites, and feed either on them or their secretions, exhibit physogastry, *i.e.* enormous over-development of the abdomen, similar to that found in the queen termites. So far as I can gather, this condition is rare or absent in myrmecophilous insects, although most of the environmental conditions are very similar in ant and termite nests. It seems possible that the guests of the termites have been affected by a growth-regulating substance produced by their hosts, analogous to those formed in the gonads and certain ductless glands of vertebrates.

Physogastry does not develop (in some at any rate of these insects) until they are nearing maturity, which may explain its slight development in the neotenic termite workers and soldiers. It would be of great interest to see whether a similar change could be produced in other insects by feeding them on termites. So far, there is no evidence for the existence of growth-regulating substances (harmazones) in insects, and it is clear that their gonads do not in general produce them. Their presence in termites would therefore be of all the greater interest.

J. B. S. HALDANE.
Biochemical Laboratory, Tennis Court Road,
Cambridge.

Direction Finding by Wireless.

I SEE that in NATURE of March 22, page 441, there is a paragraph on the subject of a paper which I read before the Institution of Electrical Engineers on March 5, 1924. In the last four lines the précis of my remarks attributes to me a statement which is inaccurate. It is quite contrary to the facts to suggest that direction finding is of little value in the Gulf of St. Lawrence or the English Channel. In the Gulf of St. Lawrence, in particular, direction finding is of the utmost value.

I shall be very much obliged if space can be afforded me to point this out, as I have already been taken to task several times for the sentence referred to, which is at variance with the remarks that I made and with the facts of the case.

JOHN A. SLEE.
The Marconi International Marine
Communication Co., Ltd.,
Marconi House, Strand, W.C.2,
April 24.

I AM sorry to have been misled by Commander Slee's appendix to his table of the actual working of ships' direction-finders. He states definitely that the charts of "bad bearing-arcs" in the St. Lawrence and English Channel Districts were available. The bearings, however, taken in these "bad arcs" were not included in his tabulated results. I am glad to hear that these bad arcs do not seriously affect the working of the method.

THE WRITER OF THE NOTE.

Ball Lightning.

By Dr. G. C. SIMPSON, F.R.S.

BALL lightning is a phenomenon which has equal interest for the meteorologist, the physicist, and the non-scientific man in the street. It has given rise to many stories which are obviously fantastic, and this has led some to doubt the reality of the phenomenon. But there can be no doubt now that ball lightning is a definite manifestation of electrical energy, and as such needs the serious consideration of scientific men.

A few attempts have been made to imitate ball lightning in the laboratory, but all that need be said about them is that they have been entirely unsuccessful. Many explanations of the phenomenon have been put forward, but these have been no more successful than the laboratory researches, and in many cases indicate that the nature of ball lightning has not been understood.

A preliminary to successful work on the nature of ball lightning, whether the work is undertaken in the laboratory or in the study, is a clear knowledge of what ball lightning is, what it does, and what are the conditions under which it appears. This can only be obtained by a critical study of the records of its appearance, undertaken by some one who has the necessary physical knowledge combined with good judgment. There have been several collections of records, but the critical discussion has not been undertaken in a completely satisfactory manner. Recently, however, Dr. Walther Brand, in Marburg a.d. Lahn, has undertaken this work, and last year his book "Der Kugelblitz," was published in Hamburg as one of a series of monographs which are being issued under the general title of "Probleme der kosmischen Physik."

Dr. Brand appears to have made a very thorough search of the literature and has found 600 accounts; of these he considers that 215, by reason of the clearness of the descriptions and the care taken in recording them, are worthy of serious study. For want of space he is only able to print about a hundred of these accounts, but he bases his discussion and statistical study on the whole 215, and gives sufficient references for any one to be turned up in the original.

When the reader has ploughed his way through the first part of Dr. Brand's work which contains the one hundred accounts, he has a feeling of the hopelessness of any attempt to formulate general laws or even general characteristics of ball lightning from such a mass of contradictory evidence. But in the second part Dr. Brand makes a masterly survey of the evidence, and slowly but surely a certain amount of order appears out of the chaos and a few general characteristics are seen. One chief cause of apparent confusion and contradiction Dr. Brand considers to be due to the fact that ball lightning has two forms—one when it floats freely through the air and the other when it moves along a body as though it were attached to it—in each of which it has quite different characteristics. Dr. Brand summarises this part of his work in fourteen "Erfahrungssätze," which on account of their importance are reproduced here.

1. Ball lightning is a rare, long-continuing, ball-shaped (less frequently pear-shaped) electrical discharge which occurs during thunderstorms. Ball lightning occurs most frequently towards the end of a thunderstorm, and winter thunderstorms are relatively more productive of ball lightning than summer thunderstorms.

2. Ball lightning generally takes the form of a red luminous ball or hollow sphere, from ten to twenty centimetres in diameter. The outline is generally hazy and the red ball appears to be surrounded by a blue region; this, however, may be due to a contrast effect. Occasionally, however, the balls are dazzlingly white, and sometimes the outline is quite sharp.

3. A hissing, humming, or fluttering sound generally accompanies the balls.

4. When they disappear the balls often leave behind them a sharp smelling smoke or mist, which appears brown by transmitted light, blue by reflected light, and occasionally white when the air is saturated.

5. The time of existence of the phenomenon varies from the smallest fraction of a second which is perceptible to several minutes; three to five seconds is, however, the most frequent period of existence.

6. Ball lightning may first appear in sight by passing out of the base of a cloud, but it may also form as a floating ball in the free air or suddenly appear sitting on some object. Frequently, but by no means always, the appearance of ball lightning is preceded by an ordinary lightning flash. When this is the case, the ball often appears on or near the place which has been struck.

7. The ball sometimes disappears quite silently, sometimes with a light crack, and sometimes with a blinding explosion. The explosions are occasionally accompanied by a number of short ordinary lightning flashes, which appear to spring out of the ball in all directions. Ordinary lightning flashes sometimes strike the balls, and so put an end to their existence.

8. The velocity with which the balls move is very variable. A ball which appears at the base of a cloud and falls to the earth moves with a considerable velocity (transition to ordinary lightning). When near the ground or in a closed room, ball lightning generally moves at about two metres a second. It can even remain stationary for a time, and cases have occurred in which ball lightning has appeared on an object, continued for some time as though boiling and emitting sparks, then disappeared without moving from the place where it appeared (transition to St. Elmo's fire). Sometimes the ball appears to be moved by air currents, but generally speaking the movement is independent of the wind.

9. Occasionally several balls appear around a place which has just been struck by ordinary lightning. A single large ball can burst and expel several smaller balls. It sometimes happens, although very seldom, that two balls appear one above the other and apparently bound together by a kind of necklace of small luminous balls. In other cases a similar short necklace appears attached to a single ball (transition to the well-known pearl-necklace lightning).

10. Floating ball lightning and attached (*aufsitzende*) ball lightning appear to behave quite differently, although they can change into one another. The

floating balls give the impression of high-tension electrical discharges without appreciable current, similar, for example, to Tesla-currents; on the other hand, the attached balls appear to possess a lower tension but greater current density.

11. The *floating* balls have the red colour of meteorites in the lower atmosphere. They shun good conductors and generally choose a path through the air. They appear to be actually "attracted" to enclosed spaces, such as houses and rooms, which they enter through the open window or door, sometimes even through small cracks. The chimney, with its conducting but self-inductionless gases, is a favourite path for the balls, so that they frequently appear to enter a house through the kitchen fire. After the ball has circulated around a room several times the latter appears to lose its power of attraction, and the ball leaves it by some aerial path, frequently the one by which it entered, but occasionally along a new one. Ball lightning, when floating in the air, is not dangerous to human beings, even when it appears in the middle of several persons. It appears to avoid them in the same way that it avoids all good conductors. Occasionally a ball makes two or three oscillatory vertical movements, which may extend to several metres or be confined to a few centimetres. When these oscillatory movements are combined with horizontal translation, the ball seems to progress in a series of hops or jumps. Frequently this vertical movement is confined to a single descent from the clouds to a few metres above the ground, followed by an immediate re-ascent.

12. The *attached* balls are dazzlingly bright, and blue or white in colour. They attach themselves to good conductors and prefer the highest points. If the conductors are horizontal, for example metal rain-gutters to roofs, the balls frequently roll along them. They heat the objects to which they are attached or along which they roll, and if the human body is such a conductor, serious burns result, sometimes with fatal effects.

13. When ball lightning is about to change from the floating to the attached state, after a short withdrawal, it makes a sudden dart on to a neighbouring good conductor, for example water. On touching the conductor it may continue to exist as an attached ball, or it may come to an end either quietly or with an explosion. Balls which fall from the clouds generally strike the ground where they explode.

14. When the reverse change is made, that is, from the attached to the free state, the ball simply rises from its support and floats upwards, generally along an inclined path towards the clouds; but usually such balls are rapidly extinguished.

The above description does not cover all the characteristics of ball lightning reported by observers, but it is a very fair representation of the outstanding features of the phenomenon. Every one who studies the reported cases may not agree with Dr. Brand regarding the relative stress he gives to the various factors, but as every characteristic tabulated can be found in several of the accounts, they must all be taken into account when formulating an explanation.

Very wisely Dr. Brand does not give much space to trying to find an explanation. He recounts the various experiments which have been made and the most important of the explanations offered, and comes to the conclusion that the problem of the nature of ball lightning is still unsolved.

The frontispiece and the last page of the book are the most intriguing and tantalising of the whole. The frontispiece shows two photographs of ball lightning, which are said to have appeared when a short circuit occurred during the tests of a 13,500 horse-power, 12,000 volt generating plant. The photographs were supplied by a Norwegian engineer, A. Nielsen, but in spite of numerous letters, Dr. Brand has been unable to extract from Herr Nielsen any details of the experience!

Chemistry at the British Empire Exhibition.

(1) FINE CHEMICALS AND SCIENTIFIC EXHIBITS.

THE Chemical Section in the great Palace of Industry at Wembley occupies nearly 30,000 square feet and is unquestionably one of the best organised, most artistically displayed, and interesting sections in the whole of the Exhibition. Very wisely the general principle has been adopted of not letting space to individual firms, each of which would, in the ordinary way, have been allowed to do what they pleased in the shape of decoration, type of stand, and method of displaying their exhibit, irrespective of the effect upon their immediate neighbours and the sections as a whole. Instead of this, blocks of space have been allocated to representative associations of the different industries, which have thus been able to deal with the exhibits of all the individual firms constituting their membership in a comprehensive and dignified manner so as to give the best effect, both collectively and individually.

Accordingly, on these lines the Chemical Section has been organised in a very efficient manner by the Association of British Chemical Manufacturers. The arrangement is such that the stands relating to heavy chemicals occupy one end, and include paints, varnishes, coal tar products, aniline dyes, disinfectants, acids and alkalis, alum, and similar products, extending to nearly the middle of the entire section. We then have fine chemicals, alkaloids, pharmaceutical products, salt, and photographic chemicals, together with an area of 2500 square feet that has been allocated to a purely "Scientific Section," another good example of the value of group control, since this would have been impossible under ordinary conditions with individual firm exhibits. Finally, at the opposite end we have soaps, perfumes, polishes, and similar products. A further great advantage of the supervision of the entire section by the Association of British Chemical Manufacturers is that not only is the whole display neat and well organised, but also well-known artists have been engaged to make the best of the section from an artistic point of view.

The wisdom of this course is seen not only by the general design, including tall and decorative gilt columns, but also by the beautiful frieze painted by Mr. Cosmo-Clark, which runs round the entire circuit of the inner walls at the top, to a total length of about 200 yards, representing, in striking colours, the chemical industry at work.

Finally we have the production of a fine volume, "Chemistry in the XXth Century," in which many well-known men of science have collaborated. It is of course quite impossible to deal adequately with such a magnificent display; and every chemist ought to make a point of visiting Wembley and studying the Chemical Section in detail, so as to be able to realise to the full the importance and diversity of his science, and the strides that have been made by Great Britain in this direction since the War.

The fine chemicals, together with the Scientific Section, is perhaps more impressive than the heavy chemicals, especially from the point of view of the resources of the British chemical industry, and there is a very fine display of alkaloids, anæsthetics, medicinal products of every description, perfumes, and pure laboratory chemicals.

Many chemists have a vague sort of idea that in these specialised branches of organic chemistry, Great Britain is behind other countries, especially Germany. A visit to Wembley will, however, soon convince them in a very emphatic manner that this is not now the case. It is of interest in this connexion to recall that when the International Exhibition was held in London in 1862, it was confidently expected that our chemical manufacturers would maintain the lead in the production of pure and heavy chemicals which they held at that time; but this promise was not fulfilled. There had been improvements since the Exhibition of 1851, and the Catalogue of the next great Exhibition contained the following notable announcement:

"A collection of products illustrating the discovery of the coal-tar dyes formed by the first workman in this fertile field, Mr. W. H. Perkin, is also exhibited: in fact, the various dyes are particularly well represented. The coal-tar series is most fully represented, and numerous specimens of the lichen and madder dyes are also exhibited. Altogether, the specimens exhibited will tend to show that England has now become the dye-producing nation of Europe, instead of having to depend on Holland, France, and other countries for the supply of lichen and madder dyes wherewith to ornament the produce of her millions of silk, woollen, and cotton looms.

"The larger and coarser kinds of chemicals, such as alum, soda, copperas, the prussiates, etc., in the manufacture of which this country has always been pre-eminent, are here as a matter of course. Some splendid specimens of salts in a high state of purity are exhibited by many well-known firms; and the more delicate materials of absolute purity for laboratory use show that English manufacturers can compete most satisfactorily with those of the Continent in this respect."

Returning to the Exhibition at Wembley, the prominence of Great Britain in the manufacture of alkaloids and similar products is well indicated by the exhibits, for example, of Messrs. Whiffin and Sons, Ltd., Messrs. May and Baker, Ltd., Messrs. Howard and Sons, Ltd., Messrs. Boots, Ltd., and Messrs. The British Drug Houses, Ltd.

Messrs. Whiffin have specialised in the large scale manufacture of alkaloids for more than seventy years, and included in the wide range of their products are to be seen atropine, hyoscine, caffeine and its salts (introduced in 1888), emetine, nicotine (largely used in horticulture for killing "green fly" and other insects), salicin (introduced in 1870), now used also in the treatment of influenza as well as rheumatism, and strychnine, first manufactured by Whiffins in 1859. Also there is shown a wide range of their well-known quinine compounds, together with camphor, and iodides, including iodoform and potassium iodide.

Messrs. May and Baker, Ltd., have also a wide range of medicinal products, including seidlitz powders, the new drug novarsenobillon ("914"), bismuth salts, mercuric chloride, and other mercury salts, the highest grades of camphor, including "flowers" entirely free from oil and moisture, the well-known "Baker" anæsthetic ether, chloroform made from acetone, and alkaloids, particularly strychnine, arecoline, and yohimbine.

Messrs. Howard and Sons' stand is arranged in the attractive form of an apothecary's shop, and included in the long list of products are quinine and cinchona products, aspirin tablets, and new synthetic products for use as special solvents in research work, such as isopropyl alcohol and cyclohexanol.

Messrs. Duncan Flockhart and Co. show a complete range of anæsthetics, vaccines, and other medicinal preparations, including the original "white label" chloroform, prepared from ethyl alcohol, the purest form of anæsthetic ether, ethyl chloride, extractions from animal glands, such as adrenalin from the suprarenal gland, pituitary fluid, and thyroid gland tablets, together with a whole list of vaccines and tuberculins, prepared in the laboratories of the Royal College of Physicians in Edinburgh. Particularly interesting is peptone, used in the treatment of special cases of spasmodic asthma.

Messrs. Burgoyne, Burbridges and Co., Ltd., have also a complete range of medicinal products, especially chloral hydrate, of which they are the largest manufacturers in Great Britain, sodium salicylate, camphor mono-bromide, and citrates, with capsules, pills, compressed tablets, amphoules, and suppositories.

Messrs. The Burroughs Wellcome Company have a striking display of their many well-known "Tabloid" fine chemical and medicinal products, including particularly compact medicine chests, the "Wellcome" brand of insulin hydrochloride, and a display of living medicinal plants from their farm at Dartford.

Messrs. J. and E. Sturge, Ltd., display precipitated chalk and various similar products for dentifrices, as well as cream of tartar and other salts of tartaric and citric acids, and Messrs. Boots Pure Drug Co., Ltd., show all kinds of medicinal products, especially insulin of their own manufacture, the new drug stabilarsen (an improvement on salvarsan), saccharine, of which they are the largest manufacturers in Great Britain, together with alkaloids, especially atropine, whilst there is included a complete model of their large works and research departments in Nottingham.

Messrs. The British Drug Houses, Ltd., an amalgamation in 1908 of a number of very old-established and well-known London firms of manufacturing chemists, display an extensive selection of their specialities, including alkaloids, pure medicinal chemicals, laboratory chemicals, pharmaceutical products, and many proprietary and toilet specialities, especially "vanishing cream." Included in this list is medicinal glucose, insulin, a product on which "B.D.H." have specialised particularly, having solved the technical problem of its production in less than three months. It is refreshing to note also that through the activities of this firm our former dependence on Germany for fine laboratory chemicals, stains for the microscope, and similar products, no longer exists. Messrs. Hopkin and Williams, Ltd., prove this also by their fine display, which includes uranium compounds for the pottery and allied industries, cerium compounds, and thorium compounds for incandescent mantles.

Perfumes are also a prominent section. Messrs. J. and E. Atkinson, Ltd., display a range of their productions, especially their well-known "eau de Cologne," and Messrs. W. J. Bush and Co., Ltd., have an extensive exhibit, not only of perfumes and essences, but also fine chemicals for all kinds of industries. Prominent is the famous Mitcham lavender water, originally introduced in 1749 by the old firm of Potter and Moore, which now belongs to Messrs. Bush, as also does Messrs. Buisson Frères. Particularly impressive are the handsome caskets and beautiful cut-glass bottles in which all the perfumes are contained. In this connexion also the stand of Messrs. E. Rimmel, Ltd., is noteworthy.

The Scientific Section, although somewhat limited in space, is full of interest for both the ordinary man and the man of science. In the centre is a striking and ingenious scientific toy, the "fiery fountain," prepared by the Manchester College of Technology, in which a graceful cascade of water falls on to a glass flower, and by some means not apparent the water appears to catch fire, giving in broad daylight various vivid colours, whilst it also shows a brilliant iridescence as it overflows into a tank below.

To the chemist, the display of alkaloids by Dr. T. A. Henry and Prof. F. L. Pyman is particularly impressive, including hyoscine, used in "twilight sleep," and the very deadly aconite alkaloids prepared from plants in Japan, India, and Great Britain, which have long been used by various savage races for poisoned arrows. British chemists and technologists, certainly unknown to the general public, have, as already indicated, always occupied a very prominent place in the science of alkaloids, and the whole of the exhibit has been prepared in Great Britain. Further, as indicating the very valuable research work undertaken in this country, there is shown a selection of the tropane alkaloids, particularly hyoscine, the iso-quinoline group, including a very large group of alkaloids, such as narcotine, cotarnine, hydrastinine, berberin, and corydaline. Again we have the glyoxaline group, the jaborandi alkaloids, such as pilocarpine and isopilocarpine, together with many purely synthetic alkaloids. In this work, the names of prominent British chemists are Jowett, Pyman, Dobbie, Lauder, Perkin, Salway, Remfrey, Plant, Barger, Field, Carr, Paul, Stedman, and White.

Prof. A. G. Perkin shows specimens relating to his well-known work on the constitution of natural dye-stuffs, as well as original specimens of artificial dye-stuffs prepared by the late Sir William Perkin, including dyeings with the original aniline dye "mauve." Natural plant dye-stuffs are also shown by Dr. Everest, whilst Prof. Hewitt has a large number of the closely related styrylpyrylium salts. As regards the terpenes, Prof. W. H. Perkin illustrates the synthesis of limonene, the first natural terpene to be prepared in the laboratory, and of epicamphor, the well-known isomeride of ordinary camphor.

In view of the rapidly increasing importance of catalysis in modern chemistry, both from a theoretical and a practical point of view, the space devoted to this question seems very small. Included, however, are specimens of hardened oils, prepared by Messrs. J. Crosfield and Sons, Ltd., and a scale model plant for the catalytic oxidation of ammonia (Messrs. The United Alkali Co., Ltd.), together with various catalytic processes in connexion with alcohol, acetaldehyde and acetic acid.

Particularly interesting is the colloid section arranged under the supervision of Prof. J. W. McBain, showing, for example, colloidal carbon, clay, and soap solutions, rubber "sols," an exhibit of dopes for aircraft work, and the filtration of colloids by the stream line filter.

Very valuable also is the exhibit arranged by Sir Robert Robertson, showing the progress in the field of explosives during the periods 1900–1924 in the same order as described in "Chemistry in the XXth Century." Nitroglycerine and nitrocellulose were manufactured on a large scale on scientific lines by 1900, together also with blasting gelatine and cordite, the first smokeless powder in fact having been introduced in 1882. There are included models showing the displacement process for making nitroglycerine, introduced by Nathan, Thomson, and Rintoul, and also of a complete acetone recovery factory. Indeed, the research section dealing with explosives is one of the most striking of all, but it is impossible to mention the many lines of research indicated in connexion with the decomposition and stability of explosives, viscosimetry, and the process of nitration. It is stated that at one time during the War, Great Britain produced every week 2000 tons of cordite, 1500 tons of trinitrotoluene, 3000 tons of ammonium nitrate, 300 tons of picric acid, and 200,000 tons of nitric and sulphuric acids. Particularly interesting is the explosive amatol, a mixture of T.N.T. and ammonium nitrate, manufactured in vast quantities, up to 4000 tons a week, for land operations.

Of great interest are the models, to an exact scale of 100 million to 1, of the crystalline structures of elements and inorganic compounds, showing the individual atoms, as prepared by Prof. W. L. Bragg, based on the analysis of the structure by means of X-rays.

Prof. A. Smithells shows the four main constituents of coal—fusian, durain, clarain, and vitrain—with photographs of the micro-structure, and Sir Ernest Rutherford has a fine exhibit from the Cavendish Laboratory, Cambridge, in connexion with radioactivity and its bearing on atomic structure, showing, for example, the method of counting the α-particles and of measuring the wave-length of the γ-rays from radium-B.

Much chemical apparatus and many general exhibits are also shown, but it is only possible to mention one or two, such as Messrs. Brunner Mond's phase rule models, Dr. F. Mollwo Perkin's display of oils from the low temperature carbonisation of coal, torbanite, lignite, and other carbonaceous products, while Dr. J. Newton Friend deals with the intricate subject of the rusting and corrosion of metals. There is also a particularly interesting collection, from the Royal Institution, of apparatus used by the late Sir James Dewar.

Finally the photographic section will be found to be of the greatest interest and assistance to devotees of this art.

Progress in Biology.[1]

By W. Bateson, F.R.S.

We have reached contemporary developments. The study of variation, and indeed of several branches of what we now call genetics, especially cross-breeding, had been pursued with vigour in the 'sixties and 'seventies, but had totally lapsed. Renewal of those inquiries led at once to an advance. We saw that the received ideas as to the magnitude of variations, and especially as to the interrelations of the domesticated breeds, were largely erroneous. As in regard to the incidence of sterility in interspecific crosses, so in regard to variation, we found ourselves among an intricate mass of empirical observations, obeying none of the principles which the orthodoxy of the time presupposed. The incidence of variation was utterly capricious, and was determined neither by utility, nor the antiquity of the feature, nor by the conditions of life, nor by any other ascertainable circumstance.

Most of the genetical work of the early time had been perfunctory and unsystematic. Godron, Naudin, Verlot, Carrière, Morren, and many more, had all seen interesting things, but they had not looked close enough. A single man, Mendel, had worked in a different fashion. Again, by one small bit of clean experimenting, a fact of a new class had been discovered. The evidence of this new witness showed us whole ranges of phenomena in their right perspective and proportions. We had at once a rationale which disposes of such outstanding mysteries as reversion and the determination of sex. Only those who remember the utter darkness before the Mendelian dawn can appreciate what has happened. Stories which then seemed mere fantasies, are now common sense. When I was collecting examples of variation in 1890, I remember well reading the fanciers' tales about dun tumbler pigeons being almost always hens, and about the "curious effects of crossing" with cinnamon canaries, but I would never have dared to repeat them, any more than Darwin ventured to quote Girou de Buzareingues (1828) to the effect that in cattle the milking-character was mainly transmitted by the bull—a proposition with which the researches of Pearl and others have now made us familiar.

Though Mendelian analysis has done all this, and very much more of which I will presently speak, it has not given us the origin of species. It has finally closed off a wrong road. I notice that certain writers who conceive themselves to be doing a service to Darwinism, take thereupon occasion to say that they expected as much, and that from the first they had disliked the whole thing. I would remind them that the class of evidence to which we were appealing was precisely that to which Darwin and every other previous evolutionist had appealed. Mendelian analysis led to the discovery of the transferable characters, not merely in sporadic instances but as a group, and the study of their behaviour enabled us to avoid endless misinterpretations into which our predecessors had consistently fallen. If we now have to recognise that the transferable characters do not culminate in specific distinctions, the acknowledgment will not come from us alone. The old belief of systematists that real species differ from each other in some way not attainable by summation of varietal characters is no longer contestable, and we know now upon what to concentrate. It is no occasion for dismay. We have not to go back very far. We do not understand specific differences, nor can we account for the adaptative mechanisms. Was it to be expected that we should? Biology is scarcely a century old, and its intensive study is of yesterday. There is plenty of time ahead.

The identification of the transferable characters and their linkages has led to a further discovery of the greatest—I might almost say, of romantic—brilliancy, which must have consequences as yet inestimable. Morgan and his colleagues have, as is well known, proved that some, probably all, of this group of characters are determined by elements transmitted in or attached to the chromosomes. It may be, as Bridges has indicated in regard to sex, that the visible distinctions are produced not so much by the presence or absence of a bit of special chromosome material, as of an interaction between the several chromosomes as a whole, and much depends on that issue; but however that may be, henceforth the study of evolution is in the hands of the cytologists acting in conjunction with the experimental breeder. As to what the rest of the cell is doing, apart from the chromosomes, we know little. We think that in plants the presence or absence of chloroplasts may be a matter of extra-nuclear transmission. Perhaps the true specific characters belong to the cytoplasm, but these are only idle speculations.

While all this has been going on we learn of advances developing from a totally different quarter—palæontology. Those whose work has lain in other fields can form only a dim and tentative understanding of these new lines of discovery. We look eagerly to the palæontologists for a full exposition. We have heard that they, especially the group of investigators connected with the American Museum, have collected wonderful series, in numbers hitherto never attainable, ranging through many geological epochs, demonstrating a continuity of succession between very dissimilar forms of life. For an introduction to this subject I am greatly indebted to Prof. D. M. S. Watson. In

[1] Continued from p. 646.

connexion with these observations we hear frequent use of the term orthogenesis, a word introduced by Eimer to express the notion that evolution proceeds along definitely directed lines.[2] Eimer was both a vigorous opponent of natural selection and a confirmed Lamarckian. His idea had been enunciated at various times by others, but in spite of a superficial attractiveness such short cuts have seemed too facile, and to be avoided in the absence of irresistible evidence that they are right. Nevertheless, what we have learned of variation, especially of the incidence of parallel variations, has taught us that many varietal forms owe their origin to a process of unpacking a definite pre-existing complex, with the consequence that, given the series of varieties to which one species is liable, successful predictions may sometimes be made as to the terms which will be found in allied series. This is not what is meant by orthogenesis, but the phenomena have features in common.

These symptoms of order in variation have prepared our minds, and there may well be a sense in which orthogenesis will be found to denote a valid principle. Granting that a gradual and secular evolution in one direction is demonstrated, much turns on the evidence that can be produced as to the other variations by which these changes have been accompanied. We anxiously await such details. Especially are we curious as to the nature of the characters concerned. Are they such as in our contemporary experiments we have found to be transferable, and thus likely to be subject to clean segregation? Secondly—a question much more difficult to answer—is it possible that, though undoubted as indications of the course of an actual evolution, the most positive indeed which can be imagined, they should be interpreted as evidence of the origin of species in that stricter sense to which genetics has introduced us?

A sound analytical classification of the several kinds of characters in respect of their modes of variation is greatly to be desired. We have determined the transferable characters as one group, and we no longer confound them with the essential elements conferring specificity. Segregation is of course often seen in species crosses, but as to the behaviour of these critical elements we know as yet very little.

Of a third group we may presently learn from the palæontologists. Independent of all these substantive characters we shall distinguish what I have called the Meristic group, as a fairly homogeneous class of phenomena recognisable without much difficulty though still not precisely defined.

That is a place to which I always look for one of the great discoveries about the nature of life. The phenomena of Meristic repetitions, especially in their most obvious manifestations as seen in simple patterns, would appear to be amenable to analysis. Who can look at the stripes on a zebra's hide—to take one of a thousand such illustrations—and not see them as a series of waves? Further, who can compare the hide of *Equus zebra* with that of *Equus grevyii* and not see that in *E. grevyii* the wave-length of the same vibrations is approximately halved? It is in the analysis of pattern that mathematical treatment might properly be applied to biology. If some physicist would examine our patterns and, treating the problem as one of ordinary mechanics, set himself to consider how the forces must be disposed to produce those patterns, I am not without hope that he might find a clue to the nature of the forces themselves.

The future of biology lies not in generalisation, but in closer and closer analysis. It is the lack of analytical penetration that we so miss in the nineteenth-century evolutionists. Phenomena the most diverse are confounded together and discussed under some common name, for example, variation. Their aim is always to unify, never to distinguish. Never are we reminded that every appeal must ultimately be to the mechanics of cell-division. That is the one true and logical unification. The cell, as Cuvier said of the living organism long ago, is a vortex of chemical and molecular change. Matter is continually passing through this system. We press for an answer to the question, How does our vortex spontaneously divide? The study of these vortices is biology, and the place at which we must look for our answer is cell-division.

[2] Artbildung u. Verwandschaft bei den Schmetterlingen, ii., 1895, p. 3.

The Toronto Meeting of the British Association.

ARRANGEMENTS for the Toronto meeting of the British Association are already well advanced. The meeting will open on Wednesday, August 6, with the installation of Sir David Bruce as president in succession to Sir Ernest Rutherford, and the delivery of the new president's address on advances in our knowledge of disease and the means of coping with and preventing it, with special reference to preventive measures used during the War. The meeting will continue until August 13; meanwhile, the International Mathematical Congress will have begun in Toronto on August 11, and on the mathematical, physical, and engineering sides especially, there will be an unique opportunity for co-operation.

The number of members intending to go to the meeting from Britain is at present about 500, and the majority will be sailing on the Cunard liner *Caronia*, leaving Liverpool on July 26, the Canadian Pacific steamer *Montrose* and the White Star *Megantic* from the same port on July 25, and the *Melita* (Canadian Pacific) from Southampton on July 24; but several other vessels will add their quota to the party, as some members are finding occasion to visit points in Canada or the United States, in advance of the meeting. The shipping companies are co-operating closely with the office of the Association in making the best arrangements possible for members; in particular, the Cunard Company is sending an officer from Liverpool to accompany the party on the *Caronia*, and to attend the meeting. The local executive committee of the Association in Toronto, under the chairmanship of Prof. J. C. McLennan, is at work arranging accommodation for visiting members, and the secretary of the Association has visited the city and discussed details of the whole organisation with the numerous active workers on the spot. There could not well be a finer situation for an Association meeting. Even the severe demands which the Association makes upon accommodation for its general and sectional meetings can easily be met in the University, while the adjacent colleges and residences will provide really delightful residence for those who do not prefer to put up at an hotel and are not staying in private houses.

The sectional programmes are taking shape. Without attempting at this stage a full list of papers, reference may be made to a few leading subjects, among which, it will be noted, Canadian interests find an important place. Sir William Bragg, as president of the Section of Mathematics and Physics (A), will give an address on crystal structure. This subject, and that of colloid solutions, will be also discussed jointly with the Chemical Section (B); while the physicists will have a session with the Engineering Section (G) to consider optical stress determination. Among other subjects in Section A, Sir Ernest Rutherford is expected to speak on atomic disintegration; Lord Rayleigh on the scattering of light, and on the luminosity of the night sky; Mr. R. H. Fowler on the quantum theory; Prof. A. S. Eddington on relativity, and on the interior of stars; Mr. E. A. Milne on stellar atmospheres; Mr. J. Jackson on star motions, and Prof. A. Fowler on spectroscopy. A group of meteorological and geophysical papers will include contributions by Mr. F. J. W. Whipple on "The Diurnal Variation of Pressure: an unsolved Riddle" and "The Green Flash"; one on tidal friction by Dr. H. Jeffreys; and one by Sir Napier Shaw, whose title, "If the World went Dry," may possibly attract attention in Toronto for reasons quite other than those offered by the subject-matter.

Sir Robert Robertson, as president of Section B (Chemistry), will speak on "Chemistry and the State." The section will join those of Physiology (I) and Agriculture (M) in a discussion on vitamins, and that of Geology (C) in the consideration of liquid and other fuels; it will itself devote a portion of the meeting to electrochemistry, with special reference to Canadian electrochemical manufactures. Section C, in a discussion on changes of sea-level in relation to gravitation, continental shelves, and coral islands, will be joined by the Geographical Section (E), the president of which, Prof. J. W. Gregory, will give an address on the relation of white and coloured races in reference to white colonisation in the tropics. Prof. G. W. O. Howe's presidential address to the Engineering Section (G) will deal with a hundred years of electrical engineering. The Anthropological Section (H) will join that of Psychology (J) in a discussion on racial mental differences, and will receive, among other contributions, papers from Mr. H. Balfour on anthropology and the administration of the affairs of native races, from Dr. A. C. Haddon on the distribution of early man, from Dr. T. Ashby on recent discoveries in Italy, from Mr. L. H. Dudley Buxton on ancient crania from the valley of Mexico, and from Dr. R. R. Marett on the cinematograph as an instrument of anthropology. Prof. W. Macdougall, in his presidential address to Section J, will deal with purposive action as a fundamental conception in psychology. The section will join that of Physiology (I) in discussing physiological and psychological factors of muscular efficiency in industry.

The Botanical Section (K) will receive an address from its president, Prof. V. H. Blackman, on the physiological aspects of parasitism; it will also deal with the ascent of sap and the transport of food material in trees, and will join in discussions on Canadian forestry problems with Section M (Agriculture), and on species and chromosomes with Section D (Zoology). Sections D and M will consider soil population. Section M will hear its president, Sir John Russell, on the subject of combination in attacking farmers' problems, and will discuss diminishing returns in agriculture with Section F (Economics). The Education Section (L) will receive an address from its president, Principal E. Barker, on the nature and conditions of academic freedom in universities, and among other items will discuss psychological tests for scholarships and promotions (jointly with Section J) and the training of pupils intended for an overseas life; it will hear Prof. Wrong on the teaching of the history and geography of the British Empire, and Dr. C. W. Kimmins on the sense of humour in children.

In addition to other papers from members of the visiting party, many are already promised by Canadian and American scientific workers, and the subjects referred to above represent perhaps a quarter (certainly not more) of those which the meeting will afford opportunity to touch upon. A large Canadian and American attendance is hoped for and expected, and several important American institutions are offering opportunities for intercourse between their representatives and visiting members. Some surprise may have been felt at the decision of the Association to meet overseas in a year when the Empire Exhibition will draw so large a number of visitors in the reverse direction across the Atlantic, but this circumstance may well react favourably upon the interests of the meeting. Those visitors to Wembley who desire to join the Association on their return may find information as to the objects and work of the Association by research in the reading room of the Canadian pavilion, or even in the ships' libraries.

The meeting will be followed by a transcontinental excursion, particulars of which may be expected shortly.

Obituary.

PROF. J. E. B. WARMING.

THE death on April 2 of Dr. Eugene Warming, emeritus professor of botany of the University of Copenhagen, marked the passing away of a vigorous force in Danish botany, and of a pioneer who influenced botany over the whole world. In the latest edition of Warming's ecological text-book (1918) references are given to about 2000 papers and monographs, and it is safe to say that the larger half of these were inspired or influenced by him. For about sixty years Warming contributed steadily to the literature of botany, and for nearly half that period he was professor. His life-work involved several aspects of botany, but the part that will probably live longest is the attempt to bring order into the chaos of the world's types of vegetation—forests, grasslands, deserts, etc.—with reference to the groups of environmental factors that determine the existence of a plant in a place, and control its growth there.

Eugene Warming was born on November 3, 1841, at Manö, near the Schleswig-Holstein frontier in Jutland, and passed his earlier life in Denmark. As with so many other northern botanists, inspiration came during a sojourn in tropical lands. Three years at Lagoa Santa, Brazil, gave many opportunities for observations on plant distribution, and one of his earlier papers (1869) was a semi-popular account of excursions over the rolling "campos" into the mountains of Brazil. "Lagoa Santa" (1892) is a classic monograph on biological plant geography, and his account of the mangrove swamps was one of the early descriptions of this type of vegetation.

Quite in another direction was the moulding influence of Warming's voyage to Greenland in 1884. His results were published in that year, and in 1887 he laid the foundation of a geographical botany of the Arctic by grouping and describing the types of vegetation. Many of the more recent papers in the "Meddelelser" (Communications on Greenland) are the work of Warming or his pupils, and include monographs on the structure, pollination, and hibernation of Arctic Heaths (1908), Saxifrages (1909), Primulaceæ (1916), and Caryophyllaceæ (1920). He also directed the publishing, in English, of "The Botany of the Færöes," a monograph of more than a thousand pages. The contributions of C. H. Ostenfeld on the land vegetation, and of F. Börgesen on the marine algæ, are the more illustrative of Warming's methods.

Much of Warming's work is comprehensive and geographical, but it is not superficial. One of his earlier contributions—"On the Structure, Hibernation, and Renewal of Shoots" (1884 and 1891)—is pioneer work. The underground structure of herbaceous perennials would appear to have received little attention until systematised by Warming. Yet the mode of over-wintering is fundamental in the existence of a plant, besides being an important factor in distribution and survival. The groups of life-forms of plants, formulated then, have been adjusted in the later editions of his text-book. In another direction his activity included taxonomy, and his "Systematic Botany" (English edition, 1895) is still a text-book. One of his earlier papers (1892) dealt with the primordia of stamens and ovules, and his maturer views, "Sur la valeur systématique de l'ovule," came in 1913. The need for research on vegetative organs appealed most to him. His "Psammophile Vegetation" (1891) and "Halophytstudier" (1897) are classics on coastal vegetation. The work of his later years was a series of monographs—"Dansk Plantevækst"—descriptive accounts of Danish plants and plant communities, including "Strand vegetation" (1906), "Klitterne" or dunes (1909), and "Skovene" completed in 1919. This last is a book of 635 pages, a unique account of plant life in forests and woodlands.

It is well for botany that all this detailed work has become the foundation of a more generalised text-book. In 1895 there was issued in Copenhagen a modest work, "Plantesamfund," Warming's lectures to his students. In 1896 it appeared in German as the "Lehrbuch der ökologischen Pflanzengeographie: eine Einführung in die Kenntnis der Pflanzenvereine." An edition, fully revised by Warming, is the English text-book, "Oecology of Plants" (1909). The latest, a book of 760 pages, with 64 pages of bibliography, appeared in Berlin in 1918. The key-note of the work is the grouping of plants into life-forms or growth-forms, determined partly by hereditary factors, partly by what Warming calls epharmony with the habitat and environment. The groups hydrophytes, mesophytes, xerophytes, and others are too familiar to need explanation. To attain a true perspective amongst the world's plant communities, Warming's outlook is absolutely necessary. If one adds the cartographical methods of Flahault of Montpellier, of Clements in America, and of the more recent Swedish school, then the whole field of plant ecology is covered.

The drift of European botany in the latter part of the nineteenth century was not too favourable to works dealing with vegetation and environment. Why this apathetic condition existed need not concern us here, but it is the case that the efforts of pioneers like Warming appealed strongly to the younger botanists with out-of-doors instincts. This has been the case in Britain, where a smaller group, the British Vegetation Committee, became in 1913 the British Ecological Society with its *Journal of Ecology*. So also in America, Warming's influence contributed to the rise of strong schools of ecology, a society, and a periodical. Contemporary schools have grown up at Montpellier and at Zurich.

Many honours were conferred on Eugene Warming. As one of the five trustees of the Carlsberg Foundation for more than twenty-five years, he exerted a great influence on Danish science through grants in aid of research and publication. He retired from his professorship in 1911 when seventy years old, after serving for just over twenty-six years (November 1885-December 1911), being followed by another great botanist, C. Raunkiaer, who was succeeded last year by C. H. Ostenfeld. In 1908 he was a delegate at the Darwin-Wallace jubilee celebration of the Linnean Society of London, of which he was elected a foreign member in 1888.

It was our good fortune to spend a fortnight in 1913 in Denmark under Warming's leadership. His enthusiasm for his native flora and vegetation was that of youth, his kindness excelled even the well-known hospitality of the Danes as a nation, and he conveyed it all with fluency in any one of four languages. Others who knew Eugene Warming personally will agree that he was a true source of inspiration, and they can understand the secret of the power of his pen. WILLIAM G. SMITH.

MR. R. STRACHAN.

AT the ripe age of ninety, Richard Strachan passed away on Easter day, April 20. He was educated at the Nautical School, Royal Hospital, Greenwich, and afterwards entered the Board of Trade. In 1855, when the Meteorological Department of the Board of Trade was initiated under the superintendence of Admiral FitzRoy, he was given charge of the Instruments Division for supplying vessels in the Navy and mercantile marine for purposes of observation in the different oceans.

Mr. Strachan contributed many useful memoirs on the meteorology of the Arctic and Antarctic, compiled from the records of the various expeditions that were sent to those regions. He also contributed numerous and varied articles on meteorological instruments to the *Horological Journal*, while many of the leading opticians were helped in their constructive work by his keen knowledge of instruments and their requirements. He joined the Royal Meteorological Society in 1865, being a fellow for practically sixty years. He served on the Council of the Society and contributed many discussions to the Society's Proceedings and Quarterly Journal.

Mr. Strachan edited a monthly *Meteorological Magazine* in 1864, but it was only current for four months, April–July; it was the precursor of *Symons' Monthly Meteorological Magazine*, which commenced in 1866 and is now continued by the Air Ministry. In 1868 he issued a pamphlet on principles of weather forecasts and storm prevision, and in 1910, ten years after retirement, a treatise on the basis of evaporation, dealing with the temperature of the sea around the British Islands.

The writer was a colleague with Mr. Strachan under the directorship of Admiral FitzRoy, and for many years later, and can testify to the ungrudging assistance given to aid in the solution of meteorological problems.

C. H.

PROF. CHARLES GODFREY, M.V.O.

As was announced in NATURE of April 12, Prof. Charles Godfrey died on April 4 at the early age of fifty years. All who are interested in the education of boys and girls realise something of his influence on the modern teaching of mathematics, even if their knowledge of him extends only to the admirable text-books of which he was one of the authors. But they do not all know that he did much more than write able books to meet an existing demand; that has been done before; it was largely his preliminary work in the cause of better teaching that created the demand for new text-books.

The revolution in school mathematics which has been in progress during the past twenty years needed a man not only with vision and driving force, but also able to bridge the gap between the actual teachers in schools and the mathematical experts who impose on them the general lines of their teaching and test its results. Prof. Godfrey was such a man, and he devoted himself to the work. He could meet the experts on their own ground, and could speak with authority on the needs and difficulties of the dull and average learner as well as those of the brilliant exception in whom the expert takes most interest. He possessed a rare combination, the enthusiasm of a reformer with a critic's detachment of mind, partly natural, no doubt, but partly acquired during a school life spent under the influence of Rawdon Levett, an eminent example of both qualities.

So equipped, Godfrey was a most valuable member of those countless committees where revolutions are planned and directed until they have gathered strength to spread of themselves. Perhaps his greatest asset for this work was his readiness to efface himself if he could thereby induce his distinguished colleagues to think that they were the initiators of his proposals. Thus the results of the experiments he carried out, first at Winchester and then at Osborne, were made available for the benefit of all schools in the British Empire and even beyond it. Only those who are able to contrast the present with former systems can fully realise the debt which mathematical education owes to Prof. Godfrey.

C. E. ASHFORD.

WE regret to announce the following deaths:

M. C. A. Angot, lately Director of the Central Meteorological Bureau, Paris, and a member of the International Meteorological Committee, on March 16, aged seventy-five.

Prof. F. H. Bigelow, formerly professor of meteorology in the United States Weather Bureau and director of the Solar and Magnetic Observatory at Pilar, Argentina, aged seventy-three.

Sir A. J. Leppoc Cappel, K.C.I.E., Director-General of Indian Telegraphs from 1883 until 1889, on April 20, aged eighty-seven.

Major F. W. Cragg, of the Indian Medical Service, and assistant director of the Central Research Institute at Kasauli, on April 23.

Dr. G. Stanley Hall, emeritus president and formerly professor of psychology of Clark University, Worcester, Massachusetts, and editor of the *American Journal of Psychology*, on April 24, aged seventy-eight.

Prof. T. C. Mendenhall, emeritus professor of physics in the Ohio State University, president of the American Association for the Advancement of Science in 1889, aged eighty-two.

Current Topics and Events.

AT the meeting of the Berlin Mikrobiological Society in the Hygienic Institute of the Veterinary School, Berlin, on April 7, the important announcement was made by Profs. Frosch and Dahmen that they had succeeded in isolating, cultivating, and photographing the long sought-for virus of foot-and-mouth disease. From the short account in the *Berliner tierärztliche Wochenschrift* (1924, xl. p. 185), just published, their success was primarily due to the fact that, regarding the fluid in the disease blisters as a reaction on the part of the infected animal, they separated the fluid from the virus which it contained by some means which they do not yet publish. In some way, also, Dahmen succeeded in getting the virus to grow on solid media and was able to propagate it in sub-culture through as many as twenty-five generations. With the 13th and 23rd generations of culture, they successfully produced the disease in guinea-pigs. With the sixth sub-culture of another strain a cow was inoculated on the muzzle and after eight days showed salivation. From this animal another cow was inoculated and developed typical foot-and-mouth disease. Frosch, continuing the account of Dahmen, describes the colonies of the virus as extraordinarily minute with a diameter not greater than that of a human red blood corpuscle (*i.e.* 7-8μ). Naturally they can only be seen with the microscope, when they appear as rounded or oval masses with a slightly crenated edge. The composition of these colonies as revealed by ultra-photographic methods (cadmium spectrum λ275) shows that they are masses of most minute rods, the smallest going to 0·1μ in length. Many appear to be in pairs. Similar bacilli have been found by the same methods in filtered blister fluid. Provisionally, the authors suggest the name of *Loeffleria nevermanni*. An apology is made for the temporary inability to publish exact details, as apparently permission has to be obtained from the Ministry of Agriculture, which gave financial aid to the research. From the experience and reputation of the two German investigators, it is very probable that their results are as stated.

ACCOMPANYING the Report of the Port Elizabeth Museum for 1923 is a leaflet headed "Only Way to tackle Locusts: Museum Director's Scheme." Mr. F. W. Fitzsimons states that, in spite of Government campaigns, the locust "menace is getting greater and greater" every year. The locusts that attack the South African Union come, he avers, from the Kalahari, where formerly they were kept under by birds, which have now been destroyed. The desert, then, should be repopulated with birds; guinea-fowl, which breed quickly, should be introduced; and penalties should be imposed on the destroyers of birds. We are wholly with Mr. Fitzsimons in his desire to destroy the locusts and to protect the birds, but he is a little rash in describing his plan as "The Only Way." Such an authority on the birds of South Africa doubtless knows that there already are two species of guinea-fowl in the Kalahari, *Numida papillosa* on the west and *N. coronata* on the east. Protect them by all means; but if the breeding-places of the locusts are away from water and devoid of scrub, the guinea-fowl will not be induced to haunt them. Also, if it is really the case that the sand-grouse and bustard have greatly diminished in numbers, by all means protect them too. Mr. Fitzsimons, however, seems to forget that locusts breed in the Transvaal and other places than the Kalahari. Besides, if the old travellers tell us of abundant game, they tell us also of huge swarms of locusts. What is the real evidence for an increasing menace? Attacks by locusts seem to occur in cycles, and it would be more profitable to discover the reason for this. Probably parasitic insects that destroy the locust in the egg will be found to enter into the story more largely than the birds. But, pending this desirable investigation, let Mr. Fitzsimons get as much protection for the birds as he can.

LOCAL AUTHORITIES have power under the Gas Regulation Act, 1920, to appoint gas examiners to carry out the provisions of the Act. The gas examiner is to be a "competent and impartial" person, but no definition is given by the terms of the Act of the meaning of the word "competent," and although the gas companies can appeal to the Chief Gas Examiner at the Board of Trade on various matters connected with the mode of testing, there would appear to be no appeal against the appointment of an incompetent gas examiner. The Gas Referees have issued a memorandum for the assistance of Local Authorities, indicating the qualifications, experience, and standing desirable for persons holding these appointments, but they have no power to enforce these recommendations, and in some cases they have been entirely disregarded by Local Authorities. On May 1, Mr. A. V. Alexander, Parliamentary Secretary to the Board of Trade, received a deputation appointed by the Councils of the Institute of Chemistry and the Institute of Physics, which have had the matter under consideration for some time past. The deputation was introduced by Major Church, Parliamentary Private Secretary, and consisted of Sir Richard Gregory, Sir Herbert Jackson, Sir Charles Parsons, Mr. E. M. Hawkins, Mr. G. Nevill Huntly, Prof. W. H. Eccles, and the officers of the Institutes of Chemistry and Physics. The deputation pointed out that in the case of public analysts, competency is defined by the Ministry of Health; and in the case of an unsuitable person being appointed, this Department has a power of veto. It was urged by the representatives of the two Institutes that it was in the public interest that the Board of Trade should possess similar powers over the appointment of gas examiners, both as regards definition of competency and power of veto. The representations of the deputation were sympathetically received by Mr. Alexander, who stated that the changes in the method of appointment of gas examiners suggested by the deputation indicated the necessity for statutory powers being granted by Parliament, and he was not in the position to promise legislation during the present session. He pointed out also that the Board must work in harmony with the Local Authorities, and that in the event of legislation being contemplated the Local Authorities would have to be consulted. It is worth consideration, however, whether the Board of Trade cannot itself undertake the responsibility of defining the "competency" of gas examiners. If so, it would not be necessary to go to Parliament for statutory powers.

THE report published in the *Times* of April 30 that the General Electric Company has succeeded in producing transparent fused quartz on a large scale, "a thousand times larger than has ever been seen in one place before," is of great technical interest, provided always that the account itself is accurate. At the present time, it seems scarcely likely that so big a technical advance in the scale of production has been made in one stage, seeing that cylinders of transparent fused silica, measuring 27½ in. long and 8½ in. in diameter, are being produced by the Thermal Syndicate in Great Britain, and that exhibits of transparent silica shown at Sir Richard Paget's recent lecture at the Royal Society of Arts are stated to have weighed 40 lb. What at present limits the size of fused silica articles is not so much technical difficulties of fusing and working on a larger scale, as the cost of the process. This, in turn, is due to the high price of the raw material for the best qualities of transparent silica, namely, rock crystal, and to the cost of the electric power required for the fusion and the processes of final shaping and finishing. At the present time, it scarcely seems likely that the cost of transparent fused silica can be so much reduced as to make it commercially practicable to produce articles of large size, as their cost would be prohibitive. No doubt there must be many new uses for transparent fused silica, as, for example, for fireproof windows and sterilisable bottles of all kinds, if only the price could be reduced nearer to the neighbourhood of that of glassware.

THE University of Naples has just been celebrating the 700th anniversary of its foundation by the Emperor Frederick II. Beginning with a reception on May 2, the celebrations extended over six days, and included the delivery in the presence of the King of Italy of addresses from twenty-six foreign universities, a gala performance at the Theatre Royal, a banquet, a regatta, and several excursions. On May 5 the delegates attended the inauguration of the fifth International Congress of Philosophy. The representatives of British universities were: Profs. J. Harrower and A. C. Baird of Aberdeen, the Rev. R. H. Semple of Belfast, the Rt. Hon. Henry Hobhouse of Bristol, Mr. Panter of Dublin, Prof. J. Wight Duff of Durham, Profs. J. Mackinnon and George Barger of Edinburgh, Mr. J. H. MacDonald of Glasgow, President D. J. Coffey of the National University of Ireland, Prof. J. A. Twemlow of Liverpool, Prof. E. A. Gardner and Dr. Walter Seaton of University College, London, the Chancellor of the University of Manchester, Dr. Ashburne and Dr. Ashby of Oxford, Prof. A. W. Seaby of University College, Reading, and Prof. H. J. Baxter of St. Andrews. " Foremost and first," says the address of the British Academy, " among the noble teachers who have rendered the University famous and honoured is Saint Thomas Aquinas," the 650th anniversary of whose death will be celebrated at Naples by an oration to be delivered by Cardinal Mercier. In point of number of students, Naples is the largest university in Italy. It has as many students as Oxford and Cambridge put together.

THE report of the Zoological Society of London for the year 1923, presented at the annual general meeting on April 29, reveals the continued flourishing state of the Society. There has been a marked increase in membership, and in the numbers of visitors to the Society's Gardens at Regent's Park, with a corresponding increase in income, and this has allowed of a greater expenditure on the maintenance and improvement of the Gardens and on the care and welfare of the animals housed there. The most important event of the year has been, of course, the completion and opening of the aquarium under the Mappin terraces. Mr. E. G. Boulenger has been appointed director of the aquarium, and he brings to his new duties an enthusiasm and an expert knowledge which should ensure the success of the new department. It will undoubtedly prove one of the most popular and interesting features of the Gardens. Zoologists will learn with thanks and relief that the efforts made by the Society for the future of the " Zoological Record " have met with success sufficient to justify the compilation of the " Record " up to the end of the current year; and the future, though by no means secure, is more hopeful for the continued publication of this invaluable volume. The interest which the Society takes in scientific literature is further emphasised by the announcement that the Society's house has been registered as the office of the Association which is engaged in the preparation and publication of a " World List of Scientific Periodicals," with indications of the libraries in Great Britain and Ireland filing the periodicals. Such a list will be of the greatest service to zoologists as well as to those engaged in other branches of science. An appreciative reference is made to the retirement of the chief clerk, Mr. W. H. Cole, after forty-six years of devoted service.

THE body known as the Agricultural Education Association has issued the first number of a journal to which it has given the ambitious title of *Agricultural Progress*. It is claimed that this journal has a place to fill as a medium for exchange of views among agricultural teachers, the latter term being used to connote, in the main, officials in the employ of Education Authorities whose main object is to apply scientific principles [*sc.* discoveries] to agricultural practice for the benefit of the farming community. The greater part of the periodical constitutes a record of the proceedings of a conference of the Association held at Aberystwyth in July last, and the remainder, and perhaps the more topical section, is a memorandum on agricultural policy submitted to the tribunal of economists appointed by the late Government to advise on measures for promoting the prosperity of agriculture. After our devastating experience of crude political remedies actual and projected, it is refreshing to find that the Association lays down that " in the revival of agriculture, research must play a vital part, because it is through improvements that success must be sought," but it is, perhaps, a melancholy admission that, as a preliminary, it is necessary to undertake " a crusade to inspire hope and stimulate activity, and to foster a spirit of inquiry, of belief in the findings of science." The journal contains a report of a stimulating address given at Aberystwyth by Sir Daniel Hall on the " Function of a College Course," of which a noteworthy section was devoted to destructive criticism of existing methods of teaching the agricultural sciences in colleges providing vocational instruction for farmers. Agriculture, it was declared, is not an assembly of applied sciences—chemistry, biology, and so forth. Agriculture has a science of its own, and that is *accountancy*. It was suggested by subsequent speakers that the pragmatic difficulty of giving effect to this view was considerable, not the least being the unattractiveness of the subject to the youthful mind. The Association may be congratulated on the interest of the contents of its maiden venture, as well as on its general make-up. It is well that a body which claims to represent the brains of agriculture should become articulate to such good purpose at this juncture.

MR. A. C. VON BAUMHAUER, Mr. R. T. Hurley, and Mr. A. Matsumoto have been elected foreign members of the Royal Aeronautical Society.

PROF. V. BJERKNES, of Bergen, is to open a discussion at the Royal Meteorological Society, on the formation of cyclones, at 5.15 P.M. on Monday, May 12.

PROF. E. MELLANBY, professor of pharmacology in the University of Sheffield, has been awarded the Stewart Prize of the British Medical Association for his discoveries on the relation between rickets and dietetic deficiency.

A MEMORIAL seat to Gilbert White, erected by the Gilbert White Fellowship, will be unveiled at Selborne, Hants, by Lady Prain, on Saturday, May 10, at 3.15 P.M. The event will be made the occasion of a pilgrimage to Selborne.

PROF. ELIHU THOMSON, of Massachusetts, U.S.A., will deliver the thirtieth James Forrest Lecture of the Institution of Civil Engineers on Tuesday, July 8. Prof. Thomson has been awarded, by the presidents of the eight British engineering institutions constituting the award committee, the triennial Kelvin Gold Medal for 1923; and formal presentation of the Medal to him will take place during the Kelvin Centenary celebration in July.

MR. IRWIN G. PRIEST has resigned from the post of secretary of the Optical Society of America; Prof. F. K. Richtmyer is acting as secretary until further notice. Communications intended for the secretary should be addressed Prof. F. K. Richtmyer, Secretary, *pro tem.*, O.S.A., Rockefeller Hall, Cornell University, Ithaca, New York.

THE Salters' Institute of Industrial Chemistry invites applications for a limited number of fellowships for post-graduate chemists who are desirous of adopting an industrial career. The fellowships are each of the annual value of 250*l.*, and fall vacant in October next. Applications should be sent, upon a prescribed form, on or before June 30, to the Director of the Institute, Salters' Hall, St. Swithin's Lane, E.C.4.

A SENIOR District Agricultural Officer is required for Tanganyika Territory. He must possess a degree or diploma in agriculture, have experience in agricultural practice and a good knowledge of tropical agriculture. Applications for the post must be made upon a form obtainable by writing to the Private Secretary (Appointments), Colonial Office, Downing Street, S.W.1. The appointment will not actually be made before the end of June.

THE following additions have been made to the list of Friday evening discourses to be delivered at the Royal Institution: Dr. Andrew Balfour, Director of the London School of Hygiene and Tropical Medicine, on historical aspects of malaria (illustrated by a Rockefeller cinematograph film); and M. Lucian Bull, Sub-Director, Institut Marey, on recent developments in high-speed cinematography.

A PRINCIPAL is required for the East Anglian Institute of Agriculture, Chelmsford. Candidates must possess a thorough knowledge of the science and practice of agriculture, and have had experience in advisory work among farmers. Particulars of the duties of the office and copies of the application form can be obtained from the clerk of the Essex County Council, Shire Hall, Chelmsford. The applications must be received by Wednesday, May 21.

DR. C. W. SALEEBY will give a lantern lecture on the value of sunlight for life and health on Wednesday, May 14, at Carnegie House Hall, 117 Piccadilly, at 5 o'clock. The object of the lecture is to interest all existing health societies, educational societies, and schools in the forming of a Sunlight League. After the lecture the chair will be taken by Dr. Somerville Hastings, M.P., and proposals will be made for the formation of a Sunlight League to form and direct public opinion on the value of sunlight for life and health and the prevention and treatment of disease. Particulars can be obtained from the Secretary, 20 Park Crescent, W.1.

APPLICATIONS are invited by the Board of Education for an assistantship on the higher technical staff in the shipping and water transport division of the Science Museum, South Kensington. Candidates should (save in exceptional cases) be from twenty-two to twenty-six years of age. They will be expected to have had a sound general training in engineering, and preferably practical experience in connexion with ship-construction and design. Further particulars and forms of application may be obtained from the Director and Secretary, Science Museum, South Kensington, S.W.7. The latest date for the receipt of applications is May 31.

THE Secretary of State for India is prepared to consider applications for a probationership for the Indian Forest Service. Candidates must be between the ages of nineteen and twenty-two, and have obtained a degree with honours in some branch of natural science in a university of England, Wales, or Ireland, or have passed the Final Bachelor of Science Examination in pure science in one of the universities of Scotland. Selected candidates are placed on probation, normally for a period of two years, for the study of forestry at Oxford, Cambridge, or Edinburgh. Applications must be received not later than July 1, on a printed form obtainable from the Secretary, Service and General Department, India Office, S.W.1, from whom full particulars may be obtained.

AT the annual meeting of the Royal Institution the following officers for the ensuing year were elected:—*President*, the Duke of Northumberland; *Treasurer*, Sir James Crichton-Browne; *Secretary*, Sir Arthur Keith; *Managers*, Lord Blanesburgh, Sir Robert Hadfield, Sir Alexander C. Mackenzie, Sir Alfred Mond, Sir Ernest Moon, Sir Charles Parsons, Sir Edward Pollock, Lord Rayleigh, Sir Robert Robertson, Sir Alfred Yarrow, Messrs. S. G. Brown, J. M. Bruce, E. Clarke, J. A. Fleming, S. W. A. Noble; *Visitors*, Sir Harry Baldwin, Messrs. A. Carpmael, E. G. Coker, E. Dent, F. H. Glew, W. J. Gow, W. E. Lawson Johnston, V. W. Low, R. Malcolm, P. St. Clair Matthey, C. H. Merz, W. Rushton Parker, H. M. Ross, J. Tennant, and Major C. E. S. Phillips.

THE seventy-seventh annual meeting of the Palæontographical Society was held on May 2 in the rooms of the Geological Society, Burlington House, Mr. E. T. Newton, president, in the chair. The annual report announced the early completion of the late Mr. F. W. Harmer's monograph of Pliocene Mollusca, and the beginning of monographs of Malacostracous Crustacea by Mr. H. Woods, and of the Oligocene Flora of Hordle by Miss M. E. J. Chandler. It also referred to the death of Prof. T. G. Bonney, who had been for many years a most active member of council. Miss Margaret C. Crosfield, Mr. F. H. Edmunds, Mr. P. Lake, and Mr. S. Hazzledine Warren were elected new members of council; Prof. W. J. Sollas was elected vice-president in succession to the late Prof. Bonney; and Mr. E. T. Newton, Mr. R. S. Herries, and Dr. A. Smith Woodward were re-elected president, treasurer, and secretary respectively. The president addressed the meeting on the early history of the Society.

ON Friday, May 2, the King and Queen, accompanied by the Duke and Duchess of York, paid an informal visit to the Exhibition at Wembley. After visiting the Palace of Engineering they made a tour of the Palace of Industry, including the Chemical Hall. The Royal party was received at one of the entrances and conducted through the Hall by Mr. W. J. U. Woolcock, general manager of the Association of British Chemical Manufacturers. Some time was spent in the Scientific Section, where the interesting exhibits by Sir John Russell, representing agriculture, and by Sir Robert Robertson, showing explosives, were noted. A copy of "Chemistry in the Twentieth Century" caught the attention of the King, who had previously accepted a specially bound copy for his own library. Some ancient Egyptian dyed fabrics were also displayed, and, as a companion exhibit, the original specimen of mauve, the historic discovery of the late Sir William Perkin.

APPROPRIATELY with the news of the Government's decision to allow entrance to the Royal Botanic Gardens at Kew free from the penny toll exacted for some years past, a new illustrated official guide to the Gardens appears (price 1*s*.). This guide briefly reviews the main objects of interest to visitors, taking them in order as they would be approached by visitors entering by one of the six public entrances to the Gardens. Simply worded descriptions are accompanied by an excellent series of photographs, views in the grounds, and illustrations of especially interesting plants. A very practical feature of the guide is a short list at the end of objects of especial interest to be found at their best in the particular month under which they are listed. We understand that new editions of the Kew hand-lists of trees and shrubs and of herbaceous and alpine plants will also be published shortly.

THE American Geographical Society, New York, announces the award of three gold medals for the year 1924 as follows: the Cullum Geographical Medal to Prof. Jovan Cvijic, the Charles P. Daly Medal to Col. Claude H. Birdseye, and the David Livingstone Centenary Medal to Mr. Frank Wild. Prof. Cvijic's achievements are well known to students of Balkan geography, for he has made substantial and original contributions in this field. Col. Birdseye is the author of several technical papers in the field of surveying, did distinguished work for the artillery service during the War, and during the summer of 1923 repeated Powell's famous exploit of descending the Grand Canyon of the Colorado by boat as leader of a topographic and hydrographic party to study the water-power possibilities of the Canyon. Mr. Frank Wild played an important part in the Scott expedition to the Antarctic, 1901–4, Shackleton's expedition, 1907–9, Sir Douglas Mawson's expedition, 1911–14. He was second in command on the Shackleton expedition of 1914–17 and during the recent expedition of the *Quest*.

ONE section of the British Industries Fair, organised through the Department of Overseas Trade, was held at the White City, Shepherd's Bush, London, on April 29–May 9. A similar Fair will subsequently be held in Birmingham on May 12–23. An important feature of the exhibits was the increased attention paid to overseas requirements and the evidences of considerable research in adapting products to special conditions in distant parts of the Empire. The exhibits in London represented exclusively British manufactures, and covered a wide range of industries. Out of the twenty sections into which they were divided, three related respectively to chemical products, scientific and optical apparatus, and wireless apparatus. Without attempting to particularise everything in these directions, it is of interest to mention that laboratory glassware was shown by four firms, namely, Duroglass Ltd. (Walthamstow), Molineaux, Webb and Co. (Manchester), J. Moncrieff, Ltd. (Perth), and Powells Thermometer Co. (Hatton Garden), the last mentioned of which had a comprehensive display of temperature-measuring apparatus for a variety of special purposes. Messrs. Brown and Son (Holloway) exhibited items of laboratory equipment; and a wide range of instruments, including aeronautical, navigational, surveying, and meteorological apparatus, was shown by Messrs. Short and Mason (Walthamstow). Wireless apparatus, chiefly broadcasting receiving sets and parts for their construction, were exhibited by about a dozen firms, and a considerable number of stands were devoted to the requirements of opticians.

THE latest catalogue (No. 458) of Mr. F. Edwards, 83 High Street, Marylebone, W.1, is entitled "Sports and Pastimes." It contains, however, particulars of many works of scientific interest under the headings of big game, dogs, falconry, fish and fishing, game birds, and horses.

WE have received from Messrs. Baker and Co., High Holborn, their classified list No. 81 of second-hand scientific instruments. A considerable assortment of instruments and apparatus of all kinds is catalogued, with the exception of photographic, which appears separately. All instruments are guaranteed to be in adjustment, and may be had on approval for three days.

THE new announcement list of Mr. John Murray contains three works likely to interest readers of NATURE, namely, "Sixty-three years of Engineering," by Sir Francis Fox; "Cancer: How it is caused, how it can be prevented," by J. Ellis Barker, with an introduction by Sir W. Arbuthnot Lane, Bart., and "Cancer Research at the Middlesex Hospital, 1900–1924: Retrospect and Prospect," edited by W. S. Handley.

ANOTHER of the well-known special catalogues of Messrs. Bernard Quaritch, Ltd., 11 Grafton Street, W.1, has reached us. Its No. is 383 and it gives nearly 2000 titles of works relating to zoology and geology. As is usual with the lists of this bookseller, many rare and costly books are offered for sale, but the catalogue also contains particulars of a yet greater number of volumes likely to be of service to men of science, priced at reasonable figures.

MR. H. GILBERT-CARTER, director of the Cambridge University Botanic Garden, has written a small book on "Descriptive Labels for Botanic Gardens," the object of which is to induce those in charge of collections of plants to exhibit them so as to give information as well as pleasure to as many people as possible and, in particular, to adopt descriptive labels similar to those in use in the Cambridge University Botanic Garden. The work will be issued shortly by the Cambridge University Press.

THE spring announcement list of Messrs. Constable and Co., Ltd., has just reached us; it contains the following books of science: In *Biology*—"Biological Foundations of Society," Prof. A. Dendy; in *Chemistry*—"Chemical Thermodynamics," Prof. J. R. Partington; in *Engineering*—"Factory Costing," H. H. Emsley; in *Geography and Travel*—"A Woman Alone in Kenya, Uganda and the Belgian Congo," Etta Close; "Red-deer Stalking in New Zealand," Captain Donne; in *Medical Science*—"Modern Views on the Toxæmias of Pregnancy," O. L. V. De Wesselow and J. M. Wyatt; "Modern Methods in the Diagnosis and Treatment of Pulmonary Tuberculosis," R. C. Wingfield; "Modern Diagnosis and Treatment of Syphilis, Chancroid and Gonorrhœa," Col. L. W. Harrison; "The Pathology and Treatment of Syphilis," Dr. C. H. Browning and Ivy Mackenzie (new edition); "Modern Methods in the Diagnosis and Treatment of Renal Disease," Dr. H. Maclean; in *Technology*—"Glass Technology," F. W. Hodkin and A. Cousen; "Pattern Making," J. M. C. Wilson; "Moulding and other Foundry Work," W. Bell.

ERRATUM.—The date of the discovery of the process by which the parasites causing malaria are extracted from the blood of the sick man and introduced into the blood of healthy individuals by Anopheles mosquitoes, given in NATURE of May 3, p. 630, col. 1, line 37, as 1899, should have been 1898.

Our Astronomical Column.

THE PROBLEM OF THE NEBULÆ.—The question of the nature of the spirals and other nebulæ has been keenly debated for more than a century, and there have been curious pendulum-like oscillations of thought on the subject; the island-universe theory has alternated with the shining-fluid one in public favour. Mr. J. H. Reynolds, who has himself played a leading part both in providing photographs and in discussing them, gives an interesting summary of the present state of the problem in the March issue of the Journal of the British Astronomical Association. He estimates the number of spirals as about 1500, this being a great reduction from the half-million that was accepted a few years ago. Very many of the latter were called spirals on insufficient evidence and are classed by Reynolds as spheroidal; he assumes that these are the more primitive, and that in some cases through increased speed of rotation, matter is ejected at their equators, ultimately forming spiral arms in the manner deduced by Jeans. As the spirals condense they become more irregular, the arms becoming S-shaped, and the nucleus diminishing in size owing to the drainage of matter into the arms. The condensations on the arms are assumed to form giant stars of type M.

The peculiar distribution of the spiral and spheroidal nebulæ is mentioned, but no explanation is suggested.

ROTATION PERIODS OF SATURN'S SATELLITES.—For several years it has been recognised as practically certain that the satellites of Saturn, at least as far out as Japetus, resemble our moon in always turning the same face to their primary: but the light variation, due to rotation, is in most cases so small, and the observation of it so difficult, that further confirmation is welcome. *Astr. Nach.*, No. 5276, contains a series of observations of Titan, Rhea, Tethys, Dione, and Enceladus, made in 1921 by K. Graff at Bergedorf. The curves for Titan and Dione are sine-curves, showing that the brightest and the darkest parts of the surface are opposite each other. Those of Rhea and Tethys are more irregular, indicating a rather complicated arrangement of spots.

Titan, Rhea, Tethys, and Dione are brightest at the eastern elongation, Enceladus and Japetus at the western one. It is pointed out that, while the indications of the rotation periods are the same as those deduced by Guthnick in 1908, the details of the light curves differ considerably. This might arise from the different presentment of their surfaces to us, their axes being probably perpendicular to their orbit planes.

GREENWICH OBSERVATIONS, 1920.—The printing of the Greenwich Observations is rapidly overtaking the serious arrears that were caused by the War. The 1920 volume contains the principal results of observations with the transit circle and altazimuth, and the observations of some 230 double stars made with the 28-inch equatorial in the years 1920 to 1923. There is a reprint of all the observations of the moon made from 1850 (when the transit-circle was erected) to the end of 1922 (when Hansen's tables were superseded by those of Brown). Various corrections have been applied both to the tabular and the observed places to reduce them to a uniform system; the annual means are given, compared with the Hansen-Newcomb positions, also with those of Brown, and with those of Fotheringham (who increased Brown's value of the secular acceleration). There are the customary details about sun-spot, magnetic, and meteorological observations. The magnetic records are reproduced for the disturbances of Feb. 24-25, March 4-5, March 22-23, Sept. 28-29, Dec. 4-5, 1920. The first and third are separated by a synodic rotation of the sun.

The volume closes with the annual report of the Astronomer Royal read on June 4, 1921.

Research Items.

BACTERIAL CONTENT OF THE ATMOSPHERE OF THE LONDON UNDERGROUND ELECTRIC RAILWAYS.—Previous work on this subject is almost limited to a report by F. W. Andrewes in 1902 on the air of the Central London Railway and to a study by G. A. Soper in 1904 of the air of New York subways. Dr. J. Graham Forbes carried out an investigation in 1920 of the air of six London electric railways (*Journ. of Hygiene*, vol. xxii., 1924, p. 123). The average of all results does not compare unfavourably with the outside air of London. The ratio of the number of organisms which develop at room temperature (about 20° C.) is about 14 for railway air to 10 for outside air, but the ratio for organisms developing at body temperature (37° C.) is considerably higher, namely 2 to 1 respectively. The mean number per litre of air, for room temperature organisms, is about 9 in railway air and 6·3 in outside air; for body temperature organisms, 4·6 in railway air and 2·2 in outside air. Increase or decrease in passenger density in the cars is generally, but not always, associated with a rise or fall in the bacterial content of railway air, affecting both groups of organisms; the actual number of organisms is affected by other factors, such as fluctuating air currents and movements of passengers. The bacterial content of platform air is generally higher than car air, probably on account of the greater amount of draught and dust disturbance. The bacterial content of car air was lowest on the Central London and highest on the City and South London, the latter being about 34 per cent. more than the former. The organisms comprised a number of species of micrococci, bacilli, sarcinæ, yeasts, streptothrices, and moulds. While some of the organisms met with occur in the mouth, nose, and on the surface of the body, in no instances were pathogenic organisms specifically proved to be present, other than certain moulds, *e.g. Aspergillus niger* and *A. fumigatus*.

DIROFILARIA IMMITIS FROM THE CAT.—In a collection of helminths from Dutch Guiana, Dr. R. J. Ortlepp records (*Journ. Helminthology*, vol. ii. pp. 15-40, 1924) a male specimen of *Dirofilaria immitis* from the heart of the domestic cat, and remarks that this appears to be the first record of the species from the cat, the usual host being the dog. The Ascarid *Lagochilascaris minor* is recorded from a mastoid abscess in man.

DIVISION OF THE NUCLEUS IN *AMŒBA PROTEUS*.—Sister Monica Taylor has utilised her rich culture material to make observations on the division of the nucleus (*Quart. Journ. Micro. Sci.*, vol. 67, pp. 39-46, 1923). The nucleus is discoidal with stout membrane, on the inner surface of which are chromatin blocks, and immersed in the nuclear sap is the plate-like karyosome, consisting of a ground substance and of small blocks which stain like chromatin. Division of the nucleus is effected when the amœbæ have withdrawn their pseudopodia and have become spherical. Each of the chromatin blocks adjacent to the nuclear membrane divides into two; this process begins at one point and gradually extends until all the blocks have so divided. The outer set of daughter products gradually separates from the inner owing to increase of nuclear sap, and the distance between the two sets increases. The karyosome divides into two, each part becoming associated with one of the sets of chromatin blocks, and the nucleus becomes " lobed " and divides into two. The nucleus may undergo rapid successive divisions into four or more. The process is not one of ordinary mitosis. The mitosis which has been observed by Miss Carter and by Doflein is attributed by the author to the sporulation cycle of the life-history.

EVOLUTION IN THE CILIATE FAMILY OPHRYOSCOLECIDÆ.—Howard Crawley has contributed (*Proc. Acad. Nat. Sci. Philadelphia*, vol. 65, pp. 393-412, 1923) a useful survey of the Ophryoscolecidæ—a family of oligotrichous ciliates most of the species of which live in large numbers either as mutualists or as commensals in the first and second stomachs of ruminants. This family is closely circumscribed and is readily distinguished from all other ciliates, and the author considers it is permissible to conclude that it is of monophyletic origin. These ciliates, developing in an isolated environment under influences which are constant, offer for study a case comparable with the fauna of a region long isolated, *e.g.* an oceanic island, and hence furnish favourable material for the study of evolution. The five genera—Entodinium, Diplodinium, Metadinium, Epidinium, and Ophryoscolex—form a linear series, the first-named being the most primitive. Generic distinctions are based on the form of the ciliary apparatus, specific on the nature of the armature present at the posterior end; these two sets of characters vary independently, " thus bringing about the unusual phenomenon of a change of genus without any change of species."

WINTER STAGE OF THE APPLE SCAB FUNGUS.—The fungus disease known as apple scab, with its tendency to produce black discoloured patches on the fruit, depreciating both market value and keeping qualities, has long been known in England, and it was also known that the so-called summer stage of the disease, in which the fungus resembles the forms placed in the genus Fusicladium, was able to persist over the winter beneath the bark of the apple shoot. E. S. Salmon and W. M. Ware now record in the *Gardener's Chronicle* for April 5 the true ascigerous stage of this fungus. The perithecia were obtained upon leaves collected in a Kentish orchard in February last; the authors state that examination of them has convinced them that the apple scab fungus is identical with the fungus described by American authors as *Venturia inaequalis*. They also report that they have found *Venturia pirina*, the winter stage of the pear scab fungus, in England.

" SLIME-FLUXES " OF TREES.—This somewhat unusual subject has been reported upon by Mr. Lawrence Ogilvie in the Transactions of the British Mycological Society, vol. 9, part iii., as the result of experiments and observations carried out at Cambridge under the guidance of Mr. F. T. Brooks. Two types of such " fluxes " are distinguished, the brown (including a red variety) considered by the author to have their origin in the exudation from the heart wood of the tree of a fairly clear liquid, which escapes through the bark either at an injury or through a natural crack in the bark. Mr. Ogilvie associates this exudation with the curious water-soaked region of the wood, recently described by Prof. W. G. Craib in his experiments at Aberdeen, which alters in distribution in the wood with the season (NATURE, July 7, 1923, p. 21). The fluxes themselves are active practically all the year round, and the author states that " practically all stages have been traced between the water-soaked areas and the typical flux." The other type of flux, the white flux, noticed mainly on willows at Cambridge, appears to be an exudation from the phloem. In both fluxes a characteristic fungus, bacterial and yeast flora, develops, which is mainly responsible for the colour of the flux, but this flora seems to be in no sense causative in the production of the flux.

CLOUD AND SUNSHINE IN NETHERLAND INDIES.—In Verh. No. 8, vol. 1, part 4, the Royal Magnetic and Meteorological Observatory of Batavia publishes, under the superintendence of Dr. C. Braak, a brief English summary of this topic, as well as a full discussion in Dutch. Causes of cloud formation are dealt with, and the daily variation of various cloud forms. Good photographic illustrations are given of the different cloud forms and cloud-caps. A typical cloud feature in the tropics is the marked diurnal variation of cloud formation. It surpasses the non-period variations and in many cases also the seasonal differences. Heavy clouds at night are quite common at Batavia in the west monsoon, and most of the rain falls at night. Cloudiness as a climatological factor is said to be much more important for the mountains than for the plains. The heaviest rainstorms do not usually reach the mountain top, but drift away to the plains after having originated on the mountain slope, and thunder is seldom heard on the top at a close range, but often at some distance above the slopes. In daytime the ascending air movement gives rise to the formation of cumulus clouds above the land, and it operates in the same way at night over the sea. Above the coast plain the height of the cumulus base is given as between 700 and 1000 metres. On the mountain slopes the first cumuli originate at a greater height, but on the exposed mountain sides the cloud base sinks much lower during a strong wind in the wet season. For the sunshine records Jordan's twin pattern recorder is generally used; thus differing from the usual sunshine recorder used in the British Isles. The whole discussion affords much material for scientific consideration.

CLIMATIC CONTINENTALITY AND OCEANITY.—In a paper read before the Royal Geographical Society on April 14, Mr. D. Brunt discussed critically Spitaler's recent work on this subject. Spitaler gave the formula $t_\phi = (A + BS_0 + CS)(1 - n) + (D + ES_0 + FS)n$ as an empirical relation connecting t_ϕ, the mean monthly temperature at sea-level for the whole of the parallel of latitude ϕ, with n, the "continentality" of the latitude, defined as the fraction of the zone between latitudes $(\phi - 1)^\circ$ and $(\phi + 1)^\circ$ which is covered by land—and with S and S_0. The latter are respectively the monthly and annual mean intensities of solar radiation for the latitude, during the time when the sun is above the horizon, no allowance being made for albedo or for absorption in the earth's atmosphere. It appeared that E was small, and it was therefore set equal to zero. On this basis, if n is put equal to 1, corresponding to a parallel of latitude covered wholly by land, t_ϕ should depend only on S, the radiation for the month in question, and not at all on S_0; this agrees with our preconceived ideas as to the quick response of land to the immediate thermal influences acting on it, and its independence of more remote influences; if, however, we put $n = 0$, t_ϕ depends both on S and S_0, in accordance with the power of the sea to retain heat over a long period. The constants A, B, C, D, and F, the same for all latitudes and months, were determined from the mean values of t_ϕ at 25 latitudes at 5° intervals, for January, July, and the annual mean; the resulting formula well represents the observed values of t_ϕ. Spitaler next proceeded to base on this formula a definition of the continentality n_c of a single station; the values of t_ϕ and S for the station, for January and July, were inserted in the formula, S_0 was eliminated, and the value (n_c) of the quantity n was determined. When thus used, the formula has the form $n_c = G + H(t'_\phi - t''_\phi)/(S' - S'')$, where G and H depend on C and F, while the single and double accents refer respectively to January and July. Charts giving iso-continental lines, or lines of equal n_c, were drawn; regions for which n_c exceeds one-half were termed continental, and the remainder were termed oceanic. The dividing line $n_c = \frac{1}{2}$ occurs some distance inland, where the prevailing wind blows from the sea. These charts are worthy of close study by those interested in climatology.

THE LOCATION OF EARTHQUAKE EPICENTRES.—Dr. S. W. Visser's latest paper (Natuurkundig Tijdschrit voor Ned.-Indie, 1923, pp. 133-153) is mainly a criticism of the methods used by the British Association Seismological Committee and the Dominion Observatory of Ottawa for locating distant earthquake epicentres. The author holds that the epicentres in each district should be determined by local seismologists, and claims that his results for the East Indies do not err by more than 0·3° from the correct position. Assuming his own determinations to be accurate, he finds the error in the British Association estimates for fifty earthquakes (1913–16) to range from 10 to 1520 km., the average difference being 293 km. In like manner, the error of nineteen Ottawa estimates (1916–20) would range from 40 to 770 km., with an average difference of 318 km. On these results, Dr. Visser comes to the following conclusions: (1) That inferences with regard to the distribution of earthquakes and the connexion with geological structure founded on such estimates are not exact; (2) that Prof. Turner's procedure in calculating the depth of the focus is not allowable when errors of several hundreds of kilometres in the horizontal direction are possible; and (3) that Prof. Turner's estimated seismic period of 21·00155 minutes is not a real one, as the errors in the positions of the epicentres may give discrepancies of nearly four minutes in the time of occurrence.

ELECTRONS IN METALS.—Although various forms of the electron theory of conduction of heat and electricity in metals have been suggested, none of them has succeeded in accounting for the whole of the facts known with regard to conduction by means of a single type of carrier of electricity such as the electron. They all lead to expressions for the Hall effect and for the thermo-electric power of a metal, and comparisons of theory and experiment have not afforded much support for the theory. In the issue of the *Physikalische Zeitschrift* for February 15, Dr. P. Raethjen gives an account of measurements of these quantities for silver, gold, platinum, copper, aluminium, tin, and palladium, undertaken at the suggestion of Prof. Kaufmann with the view of a more complete test of the theories. He finds that the two quantities show no signs of being related to each other in the way that electron theory suggests.

THE SCATTERING OF X-RAYS BY LIGHT ATOMS.—Messrs. W. Friedrich and M. Bender contribute to the *Annalen der Physik* for March an article, in which they describe measurements of the scattering of X-rays by lithium, sodium, potassium, water, and methyl alcohol, and endeavour to trace a connexion between the observed azimuthal distribution of intensity of the scattered radiation and that calculated, in accordance with Debye's views, as due to intra-atomic interference caused by the electrons of the Bohr atoms, with different assumptions as to the exact relations between the orbits. X-rays from platinum were made use of in the investigation; a tungsten filter being employed of such thickness that only the $K\alpha$ doublet was employed. Sodium and potassium were used in the liquid state, so as to avoid interferences due to the crystalline form; lithium could not be used as a liquid, as in that state it was found to act on the glass containing it. It was shown, however, that the interferences due to the crystal layers did not affect the measurements, so that solid lithium was employed. The observed scattering agrees approximately with that calculated from the electronic structure for lithium, water, and methyl alcohol, but not for sodium and potassium. That the agreement is better for scattering from an element of small atomic number than from elements of higher atomic number is only to be expected, since the possibilities of different electron structure (constellations) are not so numerous in the former as in the latter case. It is proposed to make further experiments with a very narrow beam of X-rays, so as to be able to make measurements for smaller azimuths.

SPECTRAL LINES PRODUCED BY ELECTRON COLLISIONS.—In the *Zeitschrift für Physik* for March 6, Dr. G. Hertz describes measurements of the excitation voltages required to produce different spectral lines in certain gases. The excitation voltage V for any line is given, according to the Bohr theory, by $Ve = Je - hT$, where J is the ionisation voltage, and T is the smaller of the two terms characterising the line. The difference between the excitation voltages of two lines is often only a few tenths of a volt, and it is difficult to measure such small quantities. In the usual form of apparatus employed, the different points of the incandescent cathode are at different potentials, so that the velocities of the electrons are not all the same. Dr. Hertz gets over this by using a strip of platinum foil, with a nick at the middle of each edge, as cathode, so that only the narrow portion between the nicks gets hot, and sends out electrons, the potential difference for different electrons being no more than 0·1 volt. A fine meshed grid was employed, which was connected metallically to the parallel anode plate, and disturbances due to space charge in the observation space between grid and anode were kept down by making the current density small, so that 6 to 12 hours were necessary to photograph the spectrum. Photographs are reproduced showing the mercury spectrum at 8·7 and at 9·7 volts, several new lines appearing at the higher voltage; line 3650 is absent in the first, and is much the strongest line in the second; helium at 23·6 and 24·4 volts shows a number of additional lines at the higher voltage, while with neon a series of five photographs, for voltages between 18·5 volts and 20 volts, show the gradual development of the red group of lines of this substance. With zinc, the triplet 4680, 4722, 4811 could be obtained alone, and the strong red line 6362 only appeared when the potential was raised one volt; with thallium the exciting voltage of the green line was found to be 3·5 volts, which confirms the suggestion that the $2p_2$ state of thallium is the normal one, as Grotian found by absorption measurements.

TRANSFORMATION OF DIAMOND.—Messrs. G. Friedel and G. Ribaud describe experiments on the effect of heat on the diamond in *Comptes rendus* of the Paris Academy of Sciences for March 31. Crystals from all sources show black lines, when observed between nicol prisms, which appear to be due to deformations of a substance originally isotropic. Uneven cooling of the original magma in which the crystals were formed, and external mechanical action, are not sufficient to account for the amount of double refraction observed; and it seems necessary to assume that a polymorphic transformation, accompanied by a change of volume, has taken place at a temperature when the plasticity was sufficient to allow the crystal to retain permanent deformations. Diamonds were heated in an alternating-current furnace, and the temperatures were measured with an optical pyrometer. Conversion into graphite takes place near this interesting point, so that close temperature regulation was needed. From 1500° C. on, the surface began to blacken, only a thin skin being affected. This is translucid, and consists of diamond containing a small proportion of graphite; it is hard and brilliant, is not affected by chemical reagents which oxidise graphite, but is burnt away, leaving colourless diamond, in a bunsen burner. A few minutes at 1800° causes more rapid production of graphite along the edges of the crystal. Up to 1850°-1865° the bands seen between nicols show no alteration when reobserved after cooling; but towards 1875°-1880° they show some deformation in places, indicating a certain plasticity at this temperature. When the temperature $1885 \pm 5°$ is exceeded the crystal breaks into fragments, bounded by octahedral planes of cleavage, and the bands due to double refraction undergo a complete change. It is possible to observe this only if the temperature is exceeded for a few seconds, otherwise the whole of the diamond is very rapidly converted into graphite; it seems probable that above this temperature a new form of crystal is produced, which is converted into graphite more rapidly than ordinary diamond.

CHEMICAL ANALYSIS OF COTTON.—Methods devised by the British Cotton Industry Research Association for the chemical analysis of cotton, and published in the Journal of the Textile Institute, vol. xv., No. 3, will prove of general interest both to chemical technologists and to plant physiologists. R. G. Fargher and Lucy Higginbotham describe methods by which saponification, acid, and acetyl values and unsaponifiable matter can each be determined on from 0·1 to 0·2 gm. of material. A. Geake describes a rapid sedimetric method for the estimation of phosphorus; the volume of a precipitate of strychnine phospho-molybdate is determined under standard conditions, the method being rapid and applicable to small quantities of material. B. P. Ridge describes the micro-Kjeldahl method as found trustworthy for the determination of nitrogen. From the preliminary survey of the field by these methods, Geake and Ridge find that Egyptian cotton contains appreciably more nitrogen and phosphorus than American varieties, whilst short and presumably immature hairs contain more than the longer hairs. P. H. Clifford, Lucy Higginbotham, and R. C. Fargher describe the results obtained in the extraction of raw cotton and sized and bleached goods with various fat solvents; they suggest that extraction with chloroform in a hot Soxhlet should be assumed to extract fat, wax, and resin, whilst carbon tetra-chloride extraction in an ordinary Soxhlet should be regarded as removing fat and wax only. From the same Research Association and in the same Journal is an important paper by A. R. Urquhart and A. M. Williams upon the moisture regain by cotton, which gives very definite experimental evidence that there are two possible values of moisture regain, the higher being reached if the cotton had originally been in a moister atmosphere and a lower if it had come from a drier atmosphere. Cotton previously heated to 110° C. is less able to absorb water vapour, probably because it has lost some volatile non-cellulosic constituent; soda-boiled cotton shows no such difference in behaviour after heating.

The Carnegie Trust for the Universities of Scotland.[1]

Its Work for Science.

The Carnegie Trust for the Universities of Scotland has become a factor of great value in Scottish education. For twenty years its operations have been conducted on definite general lines, but with such elasticity as has been necessary to meet changing conditions, and the simultaneous issue of the two publications here under notice affords a favourable opportunity of envisaging its work and noting its methods. This is well worth while; for the work itself has been directed to the forwarding of the development of the universities without affecting their individuality or their freedom, and the methods employed have acted to enrich their educative influences and, *pari passu,* to help students to take full advantage of the facilities offered. The past twenty years of the activities of the Trust embody sustained experiment in several problems which are now of wide public interest in Great Britain and in the Dominions. Twenty years is a short period in the history of universities, but it is long enough to afford some measure of the real value of particular methods of meeting the call for full use of their power to educate and to inspire.

The Endowment Fund of the Trust originally consisted of 10,000,000 dollars 5 per cent. Gold Bonds of the United States Steel Corporation. It is now all invested in British securities, and the annual income exceeds 120,000*l.* In instituting his Trust in 1901, Andrew Carnegie gave the following direction: "One half of the net annual income (Clause A) shall be applied towards the improvement and expansion of the Universities of Scotland in the Faculties of Science and Medicine; also for improving the opportunities for scientific study and research, and for increasing the facilities for acquiring a knowledge of History, Economics, English Literature and Modern Languages, and such other subjects cognate to a technical or commercial education, as can be brought within the scope of the University curriculum." As possible methods to these ends he set out the erection and equipment and maintenance of buildings, laboratories, classrooms, museums, or libraries; the institution and endowment of professorships and lectureships, the provision of scholarships, more especially scholarships for the purpose of encouraging research. He authorised the adoption of other methods of promoting the same general aims, but those which he directly suggested have practically sufficed for the beneficial use of the funds thus placed at the disposal of the trustees. He made it clear that assistance under these heads was to be in addition to all that could be obtained from other sources, and in the administration of their funds the trustees have found that the universities have many liberal friends.

On the second half of the net income (Clause B) the first charge is the payment, in whole or part, of the class fees of Scottish students of the universities or of recognised extra-mural colleges.

In discussing the Report of the operations of the Trust it is most convenient to take these in the following order:

(1) Improvement and expansion of the universities;
(2) Assistance to students in the payment of fees; and
(3) Post-graduate study and research.

[1] The Carnegie Trust for the Universities of Scotland. Record of Fellows and Scholars and Catalogues of Publications by Fellows, Scholars, and Recipients of Grants under the Research Scheme during the period 1903–1923. Pp. 211. Twenty-Second Annual Report (for the year 1922–23) submitted by the Executive Committee to the Trustees on 13th February 1924. Pp. iv+133. (Edinburgh: The Merchants' Hall, 1924.)

Improvement and Expansion of the Universities.

In applying funds from the first half of the net income to the provision of buildings, equipment, and staff, the trustees adopted the plan of making allocations for expenditure over periods of five years, and the current session is the last year of the fourth quinquennial period. The amounts allotted to the four universities for that period show a total of more than 200,000*l.* In this particular quinquennium the actual application of the amounts works out thus: for libraries, buildings and equipment, and books, 23,000*l.*; for other buildings and equipment, 145,000*l.*; for endowment of professorships and lectureships, 34,000*l.* (These amounts are stated in round figures.) Successive quinquennial allocations of this order, as contributions to applications of capital for the purposes indicated, have necessarily gone far to enable the Scottish universities to keep pace with the growing public demand for extension of their field and expansion of their facilities. They were of special value in the period anterior to the time of substantial Exchequer grants to the universities of the United Kingdom. They were—and are—a necessary concurrent to the other provisions of Andrew Carnegie's scheme, for these greatly stimulated the demands on the universities for advanced teaching and opportunities in science. It was not without reason that provision for buildings, equipment, and personnel was placed in the forefront among the applications of the funds of the Trust.

The cumulative effect of these grants for capital purposes is seen in the buildings and laboratories of the science departments, of which a large proportion have already been replaced or extended on modern lines and well equipped for training and research. The libraries show it as to buildings, books, and facilities for reading and consultation. Expansions of staff have permitted specialisation of function and individual teaching in science to an extent scarcely dreamt of twenty years ago. Reference to earlier annual Reports shows that the allocations to the universities for expenditure for these purposes now reach a total of about 1,000,000*l.*, applied, as stated in approximate round figures—to library buildings and books, 100,000*l.*; to other buildings and equipment, 500,000*l.*; and to endowment of professorships and lectureships, with some grants for salaries pending endowment, 400,000*l.*

Assistance to Students in Payment of Fees.

The financial encouragement which the Carnegie Trust affords to the alumni of the universities falls broadly into the two categories: (1) assistance to students in the payment of class fees during their graduation courses, and (2) scholarships and fellowships to graduates engaged in research work either as in periods of training in research or as investigators, and grants in aid of research.

The part of the Trust revenue assigned for this purpose amounts to about 60,000*l.* per annum. The great increase in the number of students after the War, coming as it did just when university fees had to be materially raised, compelled the trustees in 1921 to reduce by 1*l.* each of the rates of their aid towards sessional fees. Even as thus reduced these have been equal on the average to nearly one-half of the fees payable by the students assisted, and it has been announced that the contributions of the Trust to fee payments will now be restored to their 1920 rates. In all, the Trust's expenditure under this head in 1922–3 was 53,938*l*. and the beneficiaries numbered 4779. The distribution of the fee payments over the several faculties was as follows: arts, 2209; science, 1071; medicine, 1188; other faculties, 109. Something between one-half and three-quarters must have been payment of fees in respect of science subjects. It should be noted that in Scottish universities science studies bulk largely in the graduation courses in "arts," and that these courses include also studies of modern languages which are necessary for the equipment of science students.

A consideration which attracts attention is that the students who receive this aid number about 40 per cent. of the total number of full-time students in the four Scottish universities. Each of these universities awards to entrants a considerable number of bursaries by competition, and the Carnegie Trust's aid must count for a good deal in supplementing bursaries, many of which are of amounts determined when the standard and costs of living were much below those of to-day. Such supplements have, of course, helped to keep the doors of the universities open to promising scholars from the secondary schools of the country. None the less there may well be ground for a criticism to which the chairman of the Trust referred in presenting the Report. The general tenor of the view that had been put to him was, he said, that the Trust's assistance was so widely distributed that its amount was inadequate to meet the needs of those who most urgently required it. In discussing this point he recognised that it was desirable that the situation should be reviewed from time to time in the light of experience.

It should be noted that not a few of those who in former years have had the benefit of aid in the payment of fees, make voluntary repayments to the Trust. The average of the annual receipts from such repayments in the past five years is nearly 1400*l*.

POST-GRADUATE STUDY AND RESEARCH.

In determining the value and the conditions of tenure of the Carnegie Trust Fellowships and Scholarships, the trustees followed generally the lines which had proved effective in the system adopted by the Royal Commissioners for the Exhibition of 1851 in their scholarship scheme; but in arranging for the selection of candidates for awards they found themselves in a position to take more direct responsibility than had been possible for commissioners who had to deal with a large number of universities, and these working under very diverse conditions. The trustees make their awards through a committee on which each of the four universities is represented, and which has the assistance of expert advisers in the particular departments of study. The money value of the awards has been varied from time to time as required by economic conditions. At present each scholarship is 175*l*. and each fellowship 250*l*. Awards are in every case for one year, but each scholarship award may be repeated for a second year, or a scholar of special promise may be promoted to a fellowship and a fellowship may be repeated for a second or a third year. The scheme aims at making it possible for graduates who are qualified for research work to give some time to it exclusively, and at picking out at each stage, for further opportunities, those who are of most promise as investigators.

Grants are also made to aid investigators either in the costs of their research work or in the costs of its publication. The list of grants awarded in 1923 shows that the majority of the "grantees" are now members of the staffs of the universities.

An experiment initiated in 1919, and carried on for three years, has now taken definite shape as the Carnegie Teaching Fellowship Scheme, which aims at providing a training ground for future professors and heads of departments. A fixed grant, either 1000*l*. or 1200*l*., is made to each university to enable the university to arrange so that certain of its lecturers or assistants, selected by the university, may devote not less than half time to research, the grant from the Trust to be charged with an amount equal to one-half of the officer's salary, and the university to use this amount in providing otherwise for the teaching duties of which the Carnegie teaching fellow is relieved to set him free for his own research work. Appointment as a teaching fellow is annual, and the tenure is normally limited to three years.

Such is a brief summary of the scheme for the encouragement of research. The "Record of Fellows, etc.," affords much valuable material for judging of the effect of all its lines of action except the last named, which has now become defined.

FELLOWSHIPS AND SCHOLARSHIPS.

In the course of the twenty years now reviewed, 375 individual students of promise have held awards of scholarships and fellowships from the Trust. At the date of the record, more than 60 of these were still working under the scheme. Yet an examination of the roll of those who had passed out to employment shows that the appointments held by them were included in categories relatively easy to classify:

As Principals and Professors of Universities and Colleges	43
In other University appointments	90
In Government Scientific services	22
In Industrial Research appointments	47
In Medical Research	6
In Scholastic posts	44
Total	252

The "Catalogue of Publications" is restricted to publications prepared by fellows and scholars while *working under the scheme*, including publication of research work in respect of which the Trust had made grants towards the expense of investigation or of publication. Even thus restricted it is in itself a record of much work of moment, and it includes names of many who have made first-class contributions to the sciences to which they have devoted themselves. Such a record is no exposition of the beneficial influence of the scheme. It is rather a text for reflection, and as there is clear evidence of a generous return for the expenditure of time and money in the particular field which the Carnegie Trust has watered, the figures which illustrate the methods of application of money in the matter will form a substantial basis for any less mechanical evaluation.

Scholarships and fellowships have been awarded to 429 individuals, but of these, 54, whose aims or prospects had changed between the time of their applications and the time for taking up their awards, declined the award. Thus effective awards were made to 375 individuals, and these were on the list for periods varying from 1 to 5 years, the average period being 2¼ years. Measured by the total years of tenure by individuals, the benefits of the scheme have been distributed among the different groups of subjects in these proportions: science and medicine, 74 per cent. (being 54 per cent. to science and 20 per cent. to medicine); history, economics, and modern languages, 26 per cent.

The interruption to academic careers which resulted from the War had widely different effects on the several groups of students, and accordingly, to get material for sound inferences from the experience of this scheme, it is necessary to examine the records in sections. For the purpose of analysis here, the only awards taken into account are those concerning science and medicine. The awards classed under the general heading medicine are included, since they are simply those in respect of the sciences which in the universities are classed as in the Faculty of Medicine.

Examination of scholarship awards in the latest three years of the "Record" shows that of first awards there were, in 1922, 16 in science and 4 in medicine, but 4 of the science awards were resigned; in 1921, 13 in science and 3 in medicine, and 1 of these science awards was resigned; in 1920, 10 in science and 2 in medicine, but 1 in science and 1 in medicine were resigned. The "Record" gives definite information as to 6 of the 7 cases of resignation of the award in this three-year period. Each of these 6 students passed direct to appointments or other scholarships which afforded opportunities for research, and indeed the record of the 54 resignations of first awards, in the course of the 20 years, shows as a whole that such resignations did not by any means indicate the abandonment of research interest. Of the 16 scholars who took up science scholarships in science or medicine in 1921, 6 received awards for a second year and 4 now hold fellowships; of the 10 entering on scholarships in 1920, 9 were continued as scholars for a second year and 2 of these were thereafter promoted to fellowships. As in the case of resignations of first awards, so in the case of "scholars" passing off the awards list at the end of one or of two years, the statement of careers upon which these research students have already entered shows that their research training is destined to find much application in professional work.

For an illustration of the normal working of the scheme as to tenure of benefits through their possible currency, it is probably best to turn to the record of those students and fellows whose first awards were made in 1908 and 1909. By 1908 the scheme was in its full course, and those who began as scholars in 1909 could have completed before the outbreak of War the maximum tenure of scholarship (2 years) followed by fellowship (3 years).

In those two years, 24 awards were made to scholarships and 17 to fellowships. Of the scholars, 11 did not proceed to fellowships, and their average tenure of scholarships was 1·7 years. The other 13 scholars received awards of fellowships at the end of their first or second years of scholarship; their tenure of "research" benefits averaged, of scholarships, 1·85 years; of fellowships, 2·15 years; average total tenure, 4 years. The other 4 fellows were appointed direct to that grade and their average tenure of fellowship was 1·7 years. The average full tenure of benefits by the 24 recipients who received their first award in 1908 or 1909 was 2·75 years.

This average is rather higher than that for the whole term of existence of the scheme. This is natural, for such a general average is affected by the conditions special to the initial period and to the "War" and "after War" period. Yet examination of the details of the records for the several years suggests that the figures for the two years here selected are fairly representative of the normal working of the scheme. They may thus be of interest as indicating the general effect of adjustment which aims at affording to each "scholar" originally selected encouragement and assistance in research training and in early investigations so long—and only so long—as absorption in such experience is likely to increase the value of his real life-work.

It is obvious that the success of a scheme, which is common to all four universities and entails annual consideration of continuation of benefits, depends much on the machinery for this consideration. Here the business of the Trust rests with a committee at the meetings of which each of the universities is directly represented. The committee has the benefit also of independent expert advisers on particular groups of subjects, and the continued acceptance which attends the work of the Trust is good evidence of the soundness of their arrangements for awarding benefits among applicants drawn from four universities.

The general tabular list of fellows and scholars records in many cases the award of grants towards the cost of investigations made after the close of their fellowships or scholarships, and the list of grantees includes the names of many investigators who are members of the staffs of the Scottish universities. Of recent years, a considerable proportion of the grants for research have had reference to cost of publication, but most of the larger grants have been directed to the cost of appliances for investigations. The total amount involved in these grants is not large, but its existence is important.

The concluding passage of the introduction to the "Record" runs: "It can be claimed with some confidence that the scheme has so far accomplished its purpose, within the limits of the Trust Deed, of encouraging, extending the opportunities for, and improving scientific study and research in the Universities of Scotland." This claim is more than justified. The tale of work and service which is now published gives ample evidence of effective training of young men and women in research methods; it illustrates the benefit of such training as a preliminary whether to higher work in pure research or to valuable employment in the application of research in professions or industries. The scheme has also a wider influence; for the intellectual life of the universities, their staffs and their students, gains greatly by the perennial training of recruits for research in their midst.

Melting and Working Non-Ferrous Metals.

At the discussion on "Fluxes and Slags in Non-Ferrous Metal Melting and Working," held by the Faraday Society and the Institute of Metals on Monday, April 28, in the hall of the Institution of Mechanical Engineers, many papers were presented relating to different aspects of the use of fluxes. Prof. T. Turner presided over the first session, mainly devoted to melting operations, and Sir Robert Robertson over the second, which was concerned with welding and soldering and with the influence of non-metallic inclusions on the mechanical properties of metals.

Prof. B. P. Haigh contributed a paper on the effect of inclusions on the resistance to fatigue, and showed that the endurance limit may be lowered to one-half its normal value by slag inclusions, but that the effect depends on the shape and orientation of the slag particles rather than on their mass, since it results from local concentration of stress. The nature of the inclusions in brass was shown by Messrs. R. Genders and M. A. Haughton, who exhibited slides to show the peculiarly angular form of zinc oxide when formed in brass by the addition of cuprous oxide or some oxidising agent. Such particles would be likely to exert a considerable effect on mechanical strength, and the observations point to the desirability of removing inclusions as completely as possible. Mr. A. G. Lobley dealt with the inclusions in aluminium, and showed that whilst the metal from the reduction furnace contains chiefly particles of cryolite, oxide may be found in an entangled form in remelted metal.

Most fluxes are intended to remove oxides, and often contain deoxidisers, but a short paper by M. A. Portevin described good results obtained in melting gun-metal by the use of an oxidising flux containing red lead, the action of which is uncertain. Aluminium is usually melted without a flux, as no deoxidiser can be used, but Dr. W. Rosenhain and Mr. S. L. Archbutt described the use of fluorides and chlorides as a flux for removing oxide from scrap, and also the process of remelting the alloys of aluminium and silicon with a flux containing sodium salts, the undoubtedly good effect being attributed to the entrance of traces of sodium. Perhaps an alternative explanation may be suggested.

In his opening survey of the subject, Prof. C. H. Desch referred to the experiments of Giolitti on the influence of manganese on steel, which would seem not to be the simple one of deoxidation, but rather a specific effect in coagulating the minute suspended particles of slag, similar to, although different in principle from, the coagulation of a colloid by an electrolyte. In this connexion, reference was made to the effect of potassium chloride in destroying the "fog" of suspended particles which is formed on melting lead in contact with lead chloride, and to the influence of a small addition of calcium fluoride in order to cause the globules of molten magnesium formed by the electrolysis of molten carnallite to unite. Sir R. Robertson mentioned, as a very striking phenomenon of the same kind in another field of chemistry, the separation of an otherwise difficultly separable emulsion of nitroglycerol and waste acid by the addition of a minute quantity of sodium fluoride. The phenomena of surface tension, and of the concentration of a dissolved substance in a surface between two phases, are evidently important in all these operations, and investigation in this direction appears to be desirable. The only cases which have been studied in detail are the electrolytic production of aluminium and magnesium, when an additional complication presents itself on account of the low specific gravity of the metal, causing it to float up if the salt bath be increased in density by the addition of other substances which may be advantageous in reducing the melting point. These special conditions have led to a systematic investigation of the change of melting point and of the solubility of the oxides with variation in the mixture of fluorides or chlorides, but no similar study has been made of the slags or fluxes used for other metals.

The steel industry, which was excluded from the discussion, but from which several speakers found it convenient to draw illustrations, has dealt more thoroughly with the question, and the chemical constitution of most slags is now largely understood, thanks to the admirable work of the Geophysical Laboratory of Washington in determining the equilibria between lime, alumina, magnesia, silica, and oxides of iron. A communication by M. B. Bogitch dealt with the desulphurising action of bases and calcium fluoride, a practice adopted in steel-making and applicable to other metals. Mr. J. Phelps's paper described the slags obtained at the Royal Mint in melting alloys of silver with nickel and copper, viscous slags being more readily removed than those which are more fluid. Stirring with a roughened vertical stirrer is found to collect much of the slag so that it can be removed.

The group of papers on welding showed how empirical is the knowledge of this subject at present. Communications by Messrs. W. Spraragen, H. Ogden, and C. Coulson-Smith described the mixtures of salts which have been adopted or recommended for welding by means of the arc or of the oxy-acetylene blowpipe, from which it appears that there is little to guide the metallurgist in such a matter. It is even possible to obtain results without any flux equal to those recorded when flux has been used. The prevalence of fluorides and chlorides in the fluxes intended for use at a low temperature, and of silicates and borates in those for work at high temperatures, was noticeable in the tables given by these authors.

Mr. T. B. Crow's communication described experiments on soft soldering, directed to determining the wetting power of the solder on a metal surface alone and in the presence of various fluxes. The course of the discussion showed that surface tension effects were held to be most important in all the operations included in the papers, but that little systematic work had yet been done in connexion with them. The opener pointed out that there is an extensive literature on surface tension at high temperatures, and that many of the data required by the metallurgist actually exist, but the facts have not been collected and placed in relation to the conditions of workshop practice. When the report of this discussion is printed, there will be brought together for the first time a quantity of information concerning the fusibility of mixtures of salts and the changes in surface tension brought about by the addition of another substance, from which some indications may be derived as to the most profitable lines of research.

Valuable services are rendered by these discussions, which have become such an important part of the work of the Faraday Society. In the present instance, the discussion has revealed the paucity of information on a vitally important technical subject, and such a revelation is the first step towards securing a remedy. It is understood that the British Non-Ferrous Metals Research Association has work in hand which partly covers the ground.

Broken Hill, New South Wales.

THE Broken Hill mining district, New South Wales, has long presented many problems of exceptional interest. It is perhaps the most important lead and zinc mining district in the world; the value of the minerals raised in the district is said to exceed 111,500,000*l*., approximately one-fourth of which has been paid in dividends. The greater part of this has been derived from one line of lode only, the Broken Hill Lode, 3½ miles in length, which has yielded about 32 million tons of ore, whilst the ore reserves exceed another 13 million tons. The geology of the district and the nature of the lode itself have both given rise to numerous discussions and differences of opinion among geologists.

In 1894, the Geological Survey of New South Wales issued a Memoir on this same district by Mr. J. B. Jacquet, which was the first authoritative attempt to give a detailed account of the geology of the district. The present report[1] is a most elaborate one, and is illustrated by a large series of accompanying geological

[1] Memoirs of the Geological Survey of New South Wales. No. 8. Geology of the Broken Hill District. By E. C. Andrews.

maps. It appears to controvert the theory first put forward by Mr. E. F. Pittman, that the Broken Hill lode was a true saddle reef analogous to those in Bendigo, the deposit being now recognised as a typical replacement deposit, though the geological features are highly complex. The main stratified rocks are the so-called Willyama schists, being sillimanite and mica schists with garnet in places. These rocks underwent extensive folding and were subjected to a series of intrusions of igneous rocks, the first being the so-called footwall gneiss and granulite followed by augen-gneiss, then by basic rocks mainly amphibolites and gabbros, and finally pegmatite. Simultaneously with these igneous intrusions came excessive folding, crushing, and compression, setting up various forms of strain in which the weaker rocks were dragged against stronger ones, producing excessive crushing, whilst strains and rock flowage and actual dislocations also occurred. At the close of this period, emanations from the igneous rocks appear to have risen along the zones of strain, and the products of these were deposited within and near the harder contorted rocks. The rising emanations do not appear to have affected the strained schists below the shattered drag-folded zones, and in these zones the emanations in question produced a series of replacement deposits. Mr. Andrews sums up his views in the following sentence : " From an economic point of view, the Broken Hill Lode is a replacement merely of a complex fold."

The memoir is profusely illustrated, and contains detailed accounts of the various mines, together with information as to the methods of mining and of ore treatment. There is also some discussion of the subordinate industries connected with the mining and smelting operations, whilst important sections have been contributed on the mineralogy and petrology of the district, with a number of analyses of the more important rocks and minerals.

University and Educational Intelligence.

CAMBRIDGE.—The Balfour Zoological Library has just received a collection of 400 volumes, which formed the research library of the late Mr. Henry Roughton Hogg of Christ's College. Seventy-five of these volumes deal with the spiders and related groups. These books were given by Mrs. Hogg to Christ's College, and have been transferred with her consent to the Balfour Departmental Library.

The Local Examinations and Lectures Syndicate has presented a report to the Senate urging the formation by October 1 of a new Board to manage the Local Lectures and the Tutorial Classes. It is proposed that ten members of the Syndicate shall be members of the Senate, five others shall be elected by the Senate on the nomination of the Cambridge Local Centres' Union, and five on the nomination of the Workers' Educational Association.

The fourth report of the Board of Research Studies provides interesting reading. The numbers of research students at the end of the first four years have been 72, 143, 179, and 206. In the last academical year 22 students obtained the degree of Ph.D., 5 that of M.Sc., and 1 that of M.Litt. The number of Cambridge graduates among the research students continues to increase, the proportion to the whole number remaining about one-third. Trinity, Emmanuel, and Gonville and Caius Colleges have the largest number of such students. The departments of physics, chemistry, biochemistry, and botany have the largest number of students on the scientific side, history on the literary side.

LONDON. — Applications for Ramsay Memorial Fellowships for chemical research (one limited to candidates educated in Glasgow) will be considered at the end of June. The annual value of each fellowship will be 250*l*., to which may be added not more than 50*l*. for expenses. The fellowships are normally tenable for two years, but may be extended for a third year. Applications must be received by June 14 by the Secretary, Ramsay Memorial Fellowship Trust, University College, Gower Street, W.C.1.

Applications for grants from the Thomas Smythe Hughes Medical Research Fund for assisting medical research, accompanied by the names and addresses of two references, must reach the Academic Registrar, University of London, South Kensington, S.W.7, by June 15.

THE Toronto correspondent of the *Times* states that Sir William Mulock has been unanimously elected to succeed the late Sir Edmund Walker as Chancellor of the University of Toronto.

JUNIOR Beit Memorial Fellowships for medical research, not more than ten in number, will be awarded in July next. They will be for three years, and the annual value of each is 350*l*. Forms of application and information respecting the fellowships may be obtained by written application addressed to Sir James K. Fowler, Beit Memorial Fellowships for Medical Research, 35 Clarges Street, W.1.

THE award of the Dr. Edith Pechey Phipson post-graduate scholarship will be made in June by the Council of the London (Royal Free Hospital) School of Medicine for Women. The scholarship is of the annual value of 100*l*., tenable for not more than three years, and open to all medical women, preferably coming from India, or going to work in India, for assistance in post-graduate study. Further particulars may be had from the Warden and Secretary of the School, 8 Hunter Street, W.C.1. Applications for the scholarship must be received by May 31.

THE annual conference of the Universities of Great Britain and Ireland will be held at the British Empire Exhibition, Wembley, on Saturday, May 10. The morning session will be devoted to discussion of the directions in which universities might profitably develop, at the present time, were funds available, and the Ph.D. degree as an encouragement to higher study and research. The subjects for the afternoon session are universities and research in relation to the development of the natural resources and the industries of the Empire, and the interchange of university teachers and students within the Empire.

THE Rockefeller Medical Fellowships for the academic year 1924–1925 will be awarded by the Medical Research Council in June, and applications should be lodged with the Council not later than May 31. These fellowships are provided from a fund entrusted by the Rockefeller Foundation to the Medical Research Council, and they are awarded to graduates who have had some training in research work in the primary sciences of medicine or in clinical medicine or surgery, and are likely to profit by a period of work at a university or other chosen centre in the United States before taking up positions for higher teaching or research in the British Isles. A fellowship will have the value of not less than 350*l*. a year, with additional allowances for married men and also for travelling expenses. Full particulars and forms of application are obtainable from the Secretary, Medical Research Council, 15 York Buildings, Adelphi, London, W.C.2.

Societies and Academies.

LONDON.

Geological Society, April 9.—Dr. J. W. Evans, president, in the chair.—H. H. **Thomas** and A. H. **Cox**: The volcanic series of Roch, Trefgarn, and Sealyham (Pembrokeshire). The area dealt with lies in Northern Pembrokeshire, and stretches from Roch on the west, across the valley of the River Cleddau, to Ambleston on the east, a distance of some 9 miles. The rocks for the greater part strike approximately east and west, and the district is dominated by an east-and-west elevated tract formed of rhyolitic lavas and ashes (Roch Series). The lower ground on the south and east is occupied by rocks of Upper Cambrian and Lower Ordovician age, and in the latter two distinct volcanic series have been recognised and mapped to which the names Trefgarn and Sealyham respectively have been applied. The Roch rhyolitic series seems to be of a pre-Cambrian age.—L. **Hawkes**: On an olivine-rhyolite from eastern Iceland. The acid mass described is exposed in the cliffs of Hamarfjord, south-eastern Iceland, and is known as the "Rauthaskritha"; it has hitherto been regarded as an intrusion of dyke or stock form. It is suggested that the rhyolite was a lava-flow which filled a depression in the basaltic plateau, and was afterwards submerged beneath succeeding flows of basalt. There is evidence of the coexistence of extreme acid and basic magmas throughout the Tertiary cycle of igneous activity in Iceland. Phenocrysts of an iron-rich olivine are distributed evenly throughout the flow. The olivine-bearing acid rocks include representatives of many rock-types. It is concluded that, in the early stages of cooling, the iron orthosilicate is in equilibrium with magmas containing a considerable amount of free silica.

MANCHESTER.

Literary and Philosophical Society, April 29.—F. E. **Weiss**: A tri-hybrid Primula. A plant was obtained by pollinating the hybrid between the primrose (*Primula acaulis*) and the oxslip (*Primula elatior*) with the pollen of *Primula Juliae*, a small alpine form with purple flowers, thus obtaining a tri-hybrid Primula. The hybrid *P. acaulis* × *P. elatior* is common in Nature, and except that the flowers are born on a scape, they resemble in appearance those of a small primrose. The hairy nature of the pedicels is inherited as a dominant character from the primrose. *Primula Juliae*, a trans-Caucasian species, was first described in 1901, and introduced into England in 1912. It has a somewhat creeping habit, with small rounded leaves with distinct red leaf stalk, and bears its flowers singly on long pedicels. The pedicels and calyx are almost glabrous and so is the leaf, with the exception of its margin. The tri-hybrid Primula, *acaulis* × *elatior* × *Juliæ*, has the habit of *P. Juliæ*, and also the almost glabrous character of foliage and flowers. The flowers are also generally born singly, though in one or two cases a diminutive scape is formed. The colour of the flower is generally that of the primrose, or somewhat paler, but in two cases the plants produced purple flowers, and in one case yellow flowers with a few purple streaks. It has not been ascertained as yet whether this tri-hybrid is fertile.

PARIS.

Academy of Sciences, April 14.—M. Guillaume Bigourdan in the chair.—The president announced the death of Prince Bonaparte.—André **Blondel**: Some new applications of a method for recording the deviations or angular torsions of rotating axles.—Pierre **Weiss** and R. **Forrer**: The magnetocaloric phenomenon and the specific heat of nickel. The magnetocaloric phenomenon is defined as the disengagement of reversible heat which accompanies magnetisation. Diagrams are given showing the values of this magnitude for nickel as a function of the magnetic field for various temperatures.—Ph. **Glangeaud**: The volcano and crater lake of Issarlès (Ardèche). Their relations with the alluvio-glacial terrace of the Loire and of the Veyradeyre.—J. **Haag**: The method of least squares.—Emile **Borel**: Remarks on the preceding note.—René **Lagrange**: The absolute differential calculus.—Charles **Platrier**: The amplitudes of the torsion rotations and the resonances of torsion of transmission axles.—Joseph **Levine**: Sunspots. A simple hypothesis giving an explanation of double spots of opposite polarity.—E. **Brylinski**: Michelson's experiment. Reply to criticisms of A. Metz.—St. **Procopiu**: The appearance of the ultimate lines in electric arc spectra. The slight development of the ultimate lines of impurities in arc spectra in a vacuum, and their strong appearance in arc spectra in air, suggest a thermal mechanism as causing the emission of ultimate lines.—P. **Dejean**: The magnetic study of various arrangements of extra-soft steel cylinders, with great demagnetising fields.—H. **Hérissey** and J. **Cheymol**: The synthetic action of α-*d*-mannosidase, in the presence of ordinary glycol and of glycerol. Under the influence of α-*d*-mannosidase, mannose combines with glycol or with glycerol. As has been proved in other biochemical syntheses, the quantities of mannose combined by the ferment increase with the proportion of the alcohol present in the mixture, provided that the proportion is not so high as to affect injuriously the ferment.—Marcel **Godchot** and Pierre **Bedos**: The chlorination of inactive β-methylcyclohexanone and some syntheses of dimethylcyclohexanones.—Ph. **Négris**: Objections to the theory of drift of continents. The author criticises the theory of Wegener and concludes that it cannot be regarded as established.—Albert **Nodon**: Relations between terrestrial magnetism and the state of the atmosphere. From the facts described it is concluded that methodical observations with the magnetograph, combined with the usual meteorological observations, should prove capable of increasing sensibly the degree of precision of general and local weather forecasts.—L. **Petitjean**: A method of forecasting fog and rain.—A. **Lebediantzeff**: The distribution of fertility in an arable soil according to its depth.—G. **Guittonneau**: The formation of urea in the course of production of ammonia by the Microsiphoneæ.—André **Mayer** and L. **Plantefol**: The equilibrium of the cellular constituents and intensity of the oxidations of the cell. Imbibition and oxidation.—J. **Couvreux**: New observations on the pupillary reflexes.—A. **Tian** and J. **Cotie**: The utilisation in biology of the microcalorimetric method; example of its application. The microcalorimeter described in a previous communication has been applied to determine the heat given off under varying conditions by the domestic fly.—Pierre **Girard** and Marcel **Platard**: A new oxidation-reduction mechanism without catalysts.

CALCUTTA.

Asiatic Society of Bengal, April 2.—Hem Ch. **Das-Gupta**: Notes on a type of sedentary game prevalent in many parts of India. The game described is usually played on a plank in which a number of shallow holes has been scooped out, which are filled up with small pieces of stone, cowries, tamarind seeds, etc. It is known by various names.—N. G. **Majumdar**: An inscribed copper ladle from Hazara.—B. M. **Barua**: Notes on five Bharaut epithets. A critico-philological study of the meaning of five epithets of donors of the Bharaut railing, with reference to their significance in the literary and ecclesiastical history of the Buddhists.—Satya Churn **Law**: Observations on the breeding of some common birds in the vicinity of Calcutta. The discovery of nests of *Oriolus melanocephalus*, *Dicrurus ater*, *Ægithina tiphia*, and *Otocompsa emeria* in the months of February and March are recorded. For the latter three, the nests discovered establish earliest known records. The nest of *Otocompsa emeria* was in a plantain tree, a place not generally known to be selected for nest-building by this or any other bird. —N. **Annandale**: A working model of the origin of the Ganges in a temple in Ganjam. The model consists of stone figures associated with a tunnel of water which finally flows into a central cistern in three jets, representing the Ganges, the Jumna, and the Saraswati. The most prominent figure is that of the god Narayana, under whose left foot the water issues from a hidden pipe. Other figures represent the five heads of Mahadeva, the saint Jahnu, and the mythical mountain Sumeru. An elaborate and composite folk-tale is told to explain the model, its most characteristic feature being an account of the decay of harmony in the universe, its restoration by the divine service of Mahadeva and the ecstatic perspiration of Narayana whence the river originated.

Official Publications Received.

The Indian Forest Records. Vol. 10, Part 7: Interim Report on the Work under Projects No. 1 and No. 0 by the Section of Timber Testing, including the Results of the Mechanical and Physical Tests on certain of the commoner Indian Timbers up to the end of 1922. By L. N. Seaman. Pp. 7. (Delhi: Government Central Press.) 9 annas.

Review of Agricultural Operations in India, 1922–23. Pp. vi+155. (Calcutta: Government Printing Office.) 1.10 rupees.

Year-Book of the Department of Agriculture, Ceylon, 1924. Pp. 70+26 plates. (Peradeniya, Ceylon.)

Proceedings of the Royal Society of Edinburgh, Session 1923–1924. Vol. 44, Part 1, No. 8: On the Theory of Graduation. By Prof. E. T. Whittaker. Pp. 77–83. Vol. 44, Part 1, No. 9: The Control Field in Magnetic Hysteresis. By Dr. Robert Cochran Gray. Pp. 84–87. (Edinburgh: R. Grant and Son; London: Williams and Norgate.) 9*d*. each.

Transactions of the Geological Society of South Africa. Vol. 26, containing the Papers read during 1923. Pp. iv+163+10 plates. (Johannesburg.) 42*s*.

Proceedings of the Geological Society of South Africa. Containing the Minutes of Meetings and the Discussion on Papers read during 1923; to Accompany Vol. 26 of the Transactions, January-December 1923. Pp. xliii. (Johannesburg.)

Department of Agriculture, Jamaica. Microbiological Circular No. 1 of 1923: The Panama Disease of Bananas. By C. G. Hansford. Pp. ii+28 +4 plates. Microbiological Circular No. 3 of 1923: Tomato Diseases and their Control. By C. G. Hansford. Pp. 12. Entomological Circular No. 10: Citrus Cultivation. By C. C. Gowdey. Pp. 10. (Jamaica.)

U.S. Department of Agriculture. Farmers' Bulletin No. 1326: Control of the Codling Moth in the Pacific Northwest. By E. J. Newcomer, M. A. Yothers, and W. D. Whitecomb. Pp. 27. (Washington: Government Printing Office.) 10 cents.

Anales del Observatorio del Colegio "Ntra. Sra. de Montserrat." No. 11: Observaciones Meteorológicas de 1921. Pp. 91. (Cienfuegos, Cuba: Observatorio de Montserrat.)

Regenwaarnemingen in Nederlandsch-Indië. Vier en Veertigste Jaarhang, 1922. (Bewerkt en uitgegeven door het Koninklijk Magnetisch en Meteorologisch Observatorium te Batavia.) Pp. iii+123. (Weltevreden: Landsdrukkerij.)

Actes de la Société Helvétique des Sciences Naturelles. 102e Session annuelle du 25 au 28 août 1921 à Schaffhouse. Pp. 138+195+52. 103e Session annuelle du 24 au 27 août 1922 à Berne. Pp. 144+345+73. 104e Session annuelle du 30 août au 2 septembre 1923 à Zermatt. Pp. 132+202 +61. (Aarau: H. R. Sauerländer et Cie.)

Rocznik Astronomiczny Obserwatorjum Krakowskiego na rok 1924. Wydany przez Prof. Tad. Banachiewicza. Tom 3. Pp. iv+180+29. (Kraków.) 5 zloty.

University College of Wales, Aberystwyth: Welsh Plant Breeding Station. The Artificial Hybridisation of Grasses. By T. J. Jenkin. (Series H, No. 2.) Pp. 18. (Aberystwyth.) 3*s*. 6*d*.

The Histological and Chemical Examination of the Seeds of *Ipomœa hederacea*, Jacquin, and other Species of *Ipomœa*. By Herbert C. Kassner. (Thesis approved for the Degree of Doctor of Philosophy in the University of London.) Pp. 70. (London: Pharmacy Research Laboratory, 17 Bloomsbury Square, W.C.1.)

The Physical Society of London. Proceedings. Vol. 36, Part 3, April 15. Pp. 153–240. (London: Fleetway Press, Ltd.) 6*s*. net.

Koninklijk Nederlandsch Meteorologisch Instituut. No. 112: Report on the International Meteorological Conference of Directors and of the Meeting of the International Meteorological Committee at Utrecht, September 1923. Pp. 191. (Utrecht: Kemink en Zoon.) 2 fl.

Shirley Institute Memoirs. Vol. 2, 1923. Pp. vi+394+v. (Manchester: British Cotton Industry Research Association.)

Diary of Societies.

MONDAY, MAY 12.

VICTORIA INSTITUTE (at Central Buildings, Westminster), at 4.30.—Prof. E. Naville: Deuteronomy a Mosaic Book.

ROYAL GEOGRAPHICAL SOCIETY (at Lowther Lodge), at 5.—Captain G. T. McCaw and others: Discussion on The Proposed Adoption of a Standard Figure of the Earth.

ROYAL METEOROLOGICAL SOCIETY, at 5.15.—Prof. V. Bjerknes and others: Discussion on The Formation of Cyclones.

INSTITUTION OF MECHANICAL ENGINEERS (Graduates' Section, London), at 7.—Eng.-Captain E. C. Smith: The Makers and Making of our Modern Navy (Lecture).

TUESDAY, MAY 13.

ROYAL INSTITUTION OF GREAT BRITAIN, at 5.15.—Prof. J. Barcroft: The Effect of Altitude on Man (III.): The Mind.

INSTITUTION OF PETROLEUM TECHNOLOGISTS (at Royal Society of Arts), at 5.30.—R. K. Richardson: The Geology and Oil Measures of South-east Persia.

INSTITUTION OF CIVIL ENGINEERS, at 6.—Annual General Meeting.

ROYAL PHOTOGRAPHIC SOCIETY OF GREAT BRITAIN (Scientific and Technical Group), at 7.—C. P. Butler: Photographic Records for Astrophysical Research.—F. F. Renwick: Note on the Factors affecting Grain Size in Emulsions.

ROYAL SOCIETY OF MEDICINE (Psychiatry Section), at 8.30.—Annual General Meeting.

WEDNESDAY, MAY 14.

RADIO SOCIETY OF GREAT BRITAIN (Informal Meeting) (at Institution of Electrical Engineers), at 6.—G. G. Blake and others: Discussion on Some suggested Lines for Experimental Research.

INSTITUTION OF SANITARY ENGINEERS (at Caxton Hall, Westminster), at 7.30.—Dr. E. K. Rideal: Some Physico-chemical Factors in Water and Sewage Purification.

ROYAL SOCIETY OF ARTS, at 8.—F. C. Ingrams: Furs and the Fur Trade.

THURSDAY, MAY 15.

ROYAL SOCIETY, at 4.—Election of Fellows.—At 4.30.—Prof. A. Fowler: The Spectra of Silicon at Successive Stages of Ionisation (Bakerian Lecture).

ROYAL SOCIETY OF MEDICINE (Dermatology Section), at 5.—Annual General Meeting.

ROYAL INSTITUTION OF GREAT BRITAIN, at 5.15.—Dr. E. V. Appleton: Atmospheric Interference in Wireless Telegraphy (I.).

INSTITUTION OF MINING AND METALLURGY (at Geological Society), at 5.30. —Carbonaceous Matter at Porcupine: J. Mackintosh Bell: (1) Its Geological Occurrence.—A. Dorfman: (2) Its Metallurgy.—F. H. Edwards: The Constitution of Copper Mattes.—T. C. Phemister: A Microscopic Examination of the Insizwa Sulphide Deposits.

CHEMICAL SOCIETY, at 8.—I. E. Balaban and Dr. F. L. Pyman: The Bromo-Derivatives of 1-Methylglyoxaline and the Constitution of "Chloroxalmethylin."—R. Campbell and W. N. Haworth: Synthesis of Amygdalin. —R. G. W. Norrish and Dr. E. K. Rideal: Reactivity and Radiation. The Photochemical Union of Hydrogen and Sulphur.

ROYAL SOCIETY OF TROPICAL MEDICINE AND HYGIENE, at 8.15.—Prof. W. Yorke and Dr. J. W. Scott Macfie: Observations on Malaria made during the Malaria Treatment of General Paralysis.

FRIDAY, MAY 16.

INSTITUTION OF MECHANICAL ENGINEERS, at 6.—Third Report of the Steam-Nozzles Research Committee.

ROYAL PHOTOGRAPHIC SOCIETY OF GREAT BRITAIN, at 7.—D. H. Wilkinson: The Masters of Landscape Painting.

PHILOLOGICAL SOCIETY (at University College), at 8.

ROYAL INSTITUTION OF GREAT BRITAIN, at 9.—Very Rev. Dean W. F. Norris: The Stained Glass of York Minster.

SATURDAY, MAY 17.

BRITISH PSYCHOLOGICAL SOCIETY (at University College), at 3.—Rev. R. C. McCarthy: The Influence of Unlearned Material upon Tasks performed with Learned Material.—R. H. Thouless: The Causes of the Continuous Change of Resistance observed in Psychogalvanic Experiments.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—Dr. W. G. Alcock: How Music is Made.

PUBLIC LECTURES.

MONDAY, MAY 12.

UNIVERSITY COLLEGE, at 5.—Prof. G. Dawes Hicks: Kant's Theory of Beauty and Sublimity. (Succeeding Lectures on May 19 and 26.)

TUESDAY, MAY 13.

IMPERIAL COLLEGE—ROYAL SCHOOL OF MINES, at 5.15.—Dr. W. G. Miller: The Pre-Cambrian—with Special Reference to that of Ontario. (Succeeding Lectures on May 20 and 27.)

WEDNESDAY, MAY 14.

CARNEGIE HOUSE HALL, 117 Piccadilly, at 5.—Dr. C. W. Saleeby: The Value of Sunlight for Life and Health.

KING'S COLLEGE, at 5.30.—Prof. C. G. Seligman: Racial Problems of the Empire.

THURSDAY, MAY 15.

UNIVERSITY COLLEGE, at 2.30.—Sir W. M. Flinders Petrie: Recent Discoveries in Egypt.

INSTITUTE OF PATHOLOGY AND RESEARCH, ST. MARY'S HOSPITAL, at 5.—Dr. A. Balfour: Some Medical and Sanitary Lessons.

KING'S COLLEGE, at 5.30.—Prof. T. H. Bryce: The Development of the Human Embryo up to the Appearance of the Primitive Segments. (Succeeding Lectures on May 16, 19, and 20.)