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The Application of Science to Agriculture.

THE circumstances of the time call for the fullest possible utilisation of the national resources of both men and material, and never has there been more urgent need for the high training and intellectual interests that science can give to mankind, or for the properly directed application of science to national problems. When rapid changes are coming about before our eyes, and the community is being shaken to its foundations, it is essential to inquire whether the guardians of scientific studies in this country are still able to maintain the work at a proper level of efficiency. What, for example, is the position of the application of science to agriculture—the greatest of our industries? There have been some recent developments, though on a relatively small scale. If, however, a satisfactory organisation is possible in this case, there will be much ground for hope that the more general problem of the application of science to industry as a whole can be solved.

Prior to the war the application of science to agriculture was brought about in the main by the enterprise of a few individuals such as Lawes and Gilbert, of Rothamsted; Spencer Pickering, at the Woburn Fruit Farm; the Voelckers, father and son; and a few others. The landowner, as a rule, looked on in a not unfriendly way, but, his education never having been good, he was unable to understand what the man of science was trying to do. Character was his strong point; he administered justice in the village, while his wife dispensed charity; both were, as a rule, conscientious, hard workers, strong in the faith that they were doing the right thing, and true to the ideals that had been handed down to them by a long line of ancestors like themselves. It was not until 1894 that any sort of beginning was made in the country, when the so-called "whisky money" was available for technical education, and the county authorities had the option of developing agricultural education.

A few did so: Kent and Surrey combined to open the Wye Agricultural College; Norfolk and the eastern counties supported a school at Cambridge. The county bodies, however, did little for science. A distinction was made between "education" and "research"; if a teacher were repeating something already known, he was eligible for a Government grant, and was, therefore, a person who could be encouraged; but if he were seeking to discover something unknown, he was not eligible for grants, and was rather a problem for the authorities. Fortunately, however, institutions in the country cannot be completely governed from Whitehall, and common sense has a way of prevailing; much scientific work was, in point of fact, carried out by keen men working on their own account, and often in part at their own expense.

It was not until the passing of the Development Act in 1911 that Government support was forthcoming for scientific investigations in agriculture. The Act set up a Development Fund which subsidised certain institutions and allowed of much needed expansion. Considerable experience has been gained during the past ten years of the best method of utilising the available resources. The broad result is a threefold scheme, including: (1) Research institutions where agricultural science is developed; (2) colleges and farm institutes where instruction of various types is given to students wishing to become experts, farmers, etc.; (3) county advisers attached to some of the foregoing institutions, whose function it is to advise farmers on the various problems or difficulties with which they may be confronted.

At the beginning a rather large number of research institutes was set up, mainly at the universities. Of recent years there has been a tendency towards centralisation, four of the new institutes being afterwards transferred to other institutes already in existence. This was not originally intended, and, so far as is known, formed no part of a deliberate policy; it was the inevitable result of workers in different lines finding so much common ground that close association became essential. An institute such as Rothamsted, with excellent laboratories and library, standing in its own grounds of 300 acres, right out in the country, with well-kept historic field plots and a staff of assistants highly trained in field work, has obvious advantages over a university department situate in a town remote from agricultural practice and interests, and one is not surprised to find that it has grown and is still growing. The larger institutes now are: Rothamsted, for soil, plant nutrition, plant pathology (including entomology, helminthology, and mycology); the Imperial College, South Kensington, for plant physiology; Cambridge, for plant breeding and animal nutrition; Long Ashton and East Malling, for fruit; Reading, for dairy; Aberdeen, for animal nutrition; and Oxford, for agricultural economics.

Success or failure, however, depends on the men working the scheme, and shortly after the Armistice the Ministry of Agriculture put into operation a research service scheme, which has been found satisfactory in its essential features, and has enabled the leading research institutions to attract a body of highly competent workers and to retain those who wish to stay. Automatic increments of salary are made annually, subject to proved service, up to a certain maximum, and there is the possibility of promotion to a higher grade. As the scheme stands at present, a young man or woman taken on the staff begins with a salary which, including bonus, amounts to 450*l.* per annum, and he or she can rise continuously to a salary which, with bonus, amounts to 1010*l.* per annum. It does not follow that all will rise to this level; there are stopping places at 510*l.* and 780*l.* respectively, beyond which further progress may be impossible for a given individual. In addition, there is a superannuation scheme, to which the institute makes an annual contribution equal to 10 per cent. of the salary There are also still higher posts as directors, etc.

In the commencing or third grade the substantive salary is 300*l.* per annum, with bonus of 150*l.*, total 450*l.*, rising by annual increments of 20*l.* to 360*l.* *plus* 150*l.*—*i.e.* 510*l.* per annum. Should it appear that the holder is unsuited for the higher posts, the institute may terminate the appointment after three years. On the other hand, if paucity of posts or other reasons render promotion improbable, the institute may make the appointment permanent, provided sufficiently good work has been done to justify this course. Probably, in most institutes—certainly in the larger ones—there are excellent workers in the third grade for whom promotion into the second grade is only a remote contingency.

The middle- or second-grade appointments are limited in number—usually to half of those in the commencing grade—and the possibility of promotion thereto depends on the accident whether or not a post happens to fall vacant. Such cases inevitably arise under any scheme. The salary with bonus begins at 550*l.*, and rises by increments of 23*l.* to 780*l.* The highest or first-grade posts are also limited in number, being generally the same as the second grade; the commencing salary with bonus is 780*l.*, rising by eight annual increments to 1010*l.* The terms of appointment to these two grades are the same as those of a permanent reader at a university, so there is ample security of tenure. Above these come the directors, posts which, however, vary according to the institute.

Although the scheme is put forward, financed, and imposed on the research institutes by the Ministry of Agriculture, the holders of the posts are neither Civil Servants nor officers of the Ministry. The appointments to all these posts are made by the governing bodies of the institutes, which retain all rights of such bodies. In case of a grievance, any holder of a post has, however, the right of appeal through the governing body to the Ministry.

Promotion to a vacancy in a higher grade is possible only on the recommendation of the governing body and with the approval of the Ministry. There is a provision that all vacancies in higher grades must be notified to all likely candidates in the lower grades at all research institutes, but the appointment rests with the governing bodies, which, in the interest of their institutes, will presumably select the best candidate, whether in the service or out of it. As the scheme was originally put forward, there was a seniority clause giving preference to men or women already in the service; but this met with so much opposition from those responsible for the efficient conduct of the institutes that it was abandoned. A research institute is no place for promotion by seniority. Such promotions would stultify the whole purpose of research; they would stifle initiative, blot out all possibility of bringing in new ideas, lead to stereotyped dogmas, and do infinite harm to the cause of progress. At all costs, a research institute must choose the best possible man or woman, regardless of other considerations. Only in this way is it possible to bring in the new ideas and the new light which alone make research successful.

The reception of the scheme by the younger scientific workers has been very satisfactory, and the responsible authorities of the institutes have been in the gratifying position of finding excellent candidates for their posts. At no time in the last twenty years have the research institutes been better staffed than now.

Provision has also been made for the creation of a link between the university and the research service. The Ministry of Agriculture awards scholarships of the value of 200*l.* per annum to men and women, possessing an honours degree or equivalent qualification, who are desirous of entering the service. The successful candidates are attached to whichever institutes they may prefer, and have their opportunity in the event of a vacancy occurring. They will, however, usually find other scholarship holders at the institutes—1851 Exhibitioners, various university scholars, and other post-graduate workers also waiting for posts—and they can hope for appointments only if they happen to be the best of the available candidates.

Thus the scheme provides for selection from the universities of the most promising young men and women for research work; it allows of a probationary period in which each candidate can show his or her fitness for the work; it affords permanent posts for those finally chosen; it gives increments of salary commensurate with the value imparted by experience; and for the highly gifted worker it affords prospects of promotion to posts which, considering their freedom from routine duties and from worries, must be regarded as distinctly good. The scheme is economical and effective; it works with the minimum of friction and without interference with the individual research worker; and it may confidently be recommended as a model to other Government Departments which are concerned with the promotion of scientific research.

Philosophy of Relativity.

The General Principle of Relativity: In its Philosophical and Historical Aspect. By Prof. H. Wildon Carr. Pp. x+165. (London: Macmillan and Co., Ltd., 1920.) Price 7*s.* 6*d.* net.

PROF. WILDON CARR has produced in this little volume a really valuable book. There was an hiatus in the current expositions of the principle of relativity. Its significance and importance had been clearly set forth in their bearing on mathematical physics. But the doctrine had not been connected with its position in the history of general philosophical thought. This Prof. Carr has now done, and with great knowledge of philosophy.

After explaining the old difficulties, he shows how Descartes and Leibniz had partially recognised their origin. The exposition of the discussions by each of these thinkers is lucid and informing. In particular, there is an admirable explanation of the Leibnizian theory of monads, and of how Leibniz was driven to its adoption. Both philosophers were mathematicians of great eminence. They saw that the explanation of matter must come after that of movement, and could not precede it. Extension was not "stuff." The explanation of gravitation given by Newton follows. The book goes on to deal with the difficulties that led to Einstein's revision of the whole of the Newtonian hypothesis of space and time as absolutely existing frameworks. The special principle of relativity is then explained, and it is shown that the general, or later, Einstein principle is simply a full statement of what is implied in its earlier form. The first dealt with a definite phenomenon—the velocity of light. The second extends the explanation to the laws of Nature generally. There is no longer a particular finite velocity taken to be a constant and limiting one. As soon as we extend the special case of relativity to non-uniform and rotational systems of motion, the doctrine of equivalence between the experience of the observer taken to be at rest, and the experience of the observer in another system relatively to which the observer taken to be at rest is regarded as being in motion, becomes apparent. The explanation of the possibly non-Euclidean character of space systems, and of the necessity of correlating observations by adequate formulæ of transformation, becomes clear. The idea of pure objectivity disappears. Mind appears as relating the centre of a universe which is no longer infinite in the sense given to the word as applied to Newtonian space. For the observer is not a fixed point existing at a fixed instant. "Space and time are not containers, nor are they contents; they are variants. They change as my system of reference changes."

One of the difficulties experienced in reading even Einstein himself is the lack of a thoroughgoing connection of his principle with the new character really given by it to space and time. They are discussed as though they remained changed, not in kind, but in degree only, and based on what is original and still present, transformed in shape and measurement only. But more than this is implied in Minskowski's famous discourse at Cologne in 1908, which Einstein seems to adopt. The former deposed the intuitional space and time of our supposed direct experience to the status of mere shadows. The reality was to be sought in "the world-line," in a *continuum* the factors in which were not space and time, but deeper lying and inseparable phases of reality, to which space and time present only imperfect analogies. Some of the language of modern mathematical writers is obscured by the employment of words suggesting that we have only to correct imperfections in the description of our space and time as actual facts. Minskowski, on the other hand, seems to point to the reality being something radically different from the space and time of our discourse in science even of the most modern type. "Die dreidimensionale Geometrie wird ein Kapitel der vierdimensionalen Physik. Sie erkennen, weshalb ich am Eingange saghte, Raum und Zeit sollen zu Schatten herabsinken und nur eine Welt an sich bestehen." There is one English mathematical writer who has seized on the full meaning of this interpretation and carried it out to its logical conclusions in his "Concept of Nature." I refer to Prof. Whitehead.

The metaphysical foundations of this further view of Einstein's doctrine are made apparent in Prof. Carr's book. That is what makes it important for scientific readers, as well as for the general public, who will gather from it what the principle of relativity means. Like all books on this subject, it requires careful reading and unbroken attention, but the time these necessitate, even for this short book, will, I think, be found to have been thoroughly well spent.

HALDANE.

The Human Hand.

The Principles of Anatomy as Seen in the Hand. By Prof. Frederic Wood Jones. Pp. viii + 325 + 2 plates. (London: J. and A. Churchill, 1920.) Price 15*s*.

IN this work Prof. Wood Jones has made a notable contribution not only to the literature of human anatomy, but also to that of philosophical biology. The book is the result of an intensive study of a single part of our anatomy undertaken in the belief that if we understand it thoroughly and correctly we shall understand much more—shall, in fact, know the principles upon which the whole of our anatomy is formed. In selecting the hand for his purpose the author has chosen wisely, for it is, we think, without doubt the part which is most characteristic of us—that which has played the chief *rôle* in our development. Prof. Wood Jones's method is to take the various tissues forming the hand—viz. the skin, nails, fasciæ, bones, muscles, vessels, and nerves—separately, describing them in considerable detail from both the morphological and the practical points of view. As we can readily imagine, he is not able to confine himself strictly to the hand, any more than was Sir Charles Bell in his century-old book on the same subject. (We might say in passing that the comparison between the two books, which are further alike in that they are largely illustrated by the authors themselves, is extremely interesting and illuminating, as showing the great advance in our knowledge and the great change which has come over our conception of man's place in Nature during the last hundred years.)

From internal evidence alone the book appears to have been begun as a morphological study, and to have been given its practical bias in consequence of experience with patients suffering from nerve lesions acquired in the war. The fact—if fact it be that this was the order of its evolution—will go far, we think, to explain the peculiar value and interest of the book. It is seldom that anatomy is treated from both the morphological and the practical points of view; here, however, we have a book in which this is not merely observed, but impartially observed, with a result which, we believe, completely justifies those who look upon morphology as the guiding spirit of anatomical research, and upon anatomy itself as the only solid basis on which scientific medicine and surgery can be founded. An admirable example of the close connection which exists between morphology, anatomy, medicine, and surgery is, we think, to be found in the chapter on the skin creases or flexure lines, subjects which, we agree with the author, have not been given the consideration they deserve by either the physician or the surgeon.

In the chapter on the osteology of the hand the form of the primitive vertebrate hand is discussed at some length, and the conclusion reached that the primitive hand was not only pentadactylous, but also characterised by a smaller number of phalanges in the preaxial digit. The discrepancy in the number of phalanges in this digit compared with those in the other digits may, of course, be due to a decrease in the preaxial or to an increase in the other digits. Despite the fact that, as is pointed out and emphasised, no animal living or extinct has more than two phalanges in the preaxial digit, whereas the number of phalanges in the other digits is frequently subject to increase, Prof. Wood Jones accepts the former of the two alternative explanations, and hazards the opinion that the reduction has been brought about by the fusion of the two terminal phalanges. If on this matter he is not so logical as we could wish, we are more content with him in certain of his other explanations, and think the reasons he gives for the fusion of the fourth and fifth carpalia and tarsalia to form the unciform and cuboid, and for the shifting of the axis of the foot from the line of the third toe to that of the second, both adequate and ingenious. We are inclined also to accept his view of the fate of the os centrale, although here, as in other parts of the book, we think it would have been well if the evidence from morphology had been supplemented with that obtainable from embryology. The curious order in which the bones of the hand ossify is a matter upon which we should like to have had some light, but, unfortunately, none is forthcoming.

In the chapter on the extrinsic muscles of the hand reference is made to the muscles of the foot, and the extensor brevis digitorum and the peroneus tertius are spoken of as derivable from a deep extensor sheet, the slips to the four inner toes passing down into the foot, while the slip to the little toe remained in the leg as the peroneus tertius. This is a view of the origin of these muscles which is in direct opposition to those of Ruge, Bryce, and Keith, for they have shown that the extensor brevis digitorum, despite its innervation, has entered the foot, not from above, but from behind, passing under the external malleolus, while the peroneus tertius has originated in quite a different fashion—by segmentation of the extensor longus digitorum. The matter is, of course, of almost purely morphological interest, but we have ventured to refer to it because of the interesting problem presented by the nerve-fibres for the extensor brevis digitorum changing from the musculo-cutaneous branch to the anterior tibial branch of the external popliteal nerve.

Perhaps the most original and valuable part of the book is that dealing with muscles and their action. Here we have the results of a singularly close study of the various muscles of the hand, both in health and in disease, both after organic lesions and after functional disturbances, results which enable the author to furnish us with the very useful classification of muscles into prime movers, antagonistic, synergic, and fixation muscles, according to the particular part they play in different movements. We are also given the exact meaning of the phrase "at rest" as applied to a limb or a muscle, and supplied with a physiological explanation as to when and why the position of rest is attained. The distinction between a limb which is immobilised or mechanically at rest and one naturally at rest is clearly drawn. In the chapters dealing with the nerves an interesting summary is given of the most recent work of Head, Elliot Smith, Kinnier Wilson, and other neurologists—a summary supplemented by many original observations and speculations, as, for example, the particular association of trophic effects with injury to the median nerve, and the possibility that the Pacinian corpuscles are part of the sympathetic sensory system the fibres of which in the hand run mainly in the median nerve.

Altogether, the book is one which, in our opinion, places its author in the front rank of anatomists, and does more, we think, than any book published in recent years to rehabilitate the subject of anatomy, and restore it to its rightful place as the most fundamental and pervasive subject in the medical curriculum. W. W.

Identification of Monosaccharides.

Anleitung zum Nachweis, zur Trennung und Bestimmung der reinen und aus Glukosiden usw. erhaltenen Monosaccharide und Aldehydsäuren. By Dr. A. W. van der Haar. Pp. xvi + 345. (Berlin: Gebrüder Borntraeger, 1920.) Price 64 marks.

THROUGHOUT the development of organic chemistry the glucosides have maintained, amongst phytochemical products, a position of interest primarily due to their connection with sugars. Their attraction as materials for chemical study is intrinsic also, because they present alluring structural problems, and reveal the power of sugar molecules to combine with a great variety of other types—for example, in amygdalin, myronic acid, indican, and salicin. Furthermore, it is largely upon the production and examination of artificial glucosides that our present conception of glucose itself is based.

The diagnosis of a natural glucoside is complete only when the carbohydrate component has been identified, and chemists have long been conscious of the difficulties inherent to such an operation, especially when only small quantities of material are available. The purpose of the work under review is to facilitate this procedure, and the author has assembled in concise form the vast collection of experimental observations which have been accumulated in this field. Thus the volume offers ample and valuable information to those concerned in the identification of monosaccharides.

It is axiomatic that in such a treatise much attention should be devoted to the formation and properties of the large class comprising condensation products derived from substituted hydrazines, and the latter half is allotted almost entirely to this voluminous branch. The service thus rendered is conspicuous, for, in addition to arranging in logical sequence the numerous and scattered records of previous investigators, the author has elaborated methods based on his own research for dealing with mixtures containing two, three, and four monosaccharides. Due notice is given also to the recognition and estimation of glycuronic acid, the importance of which in glucoside chemistry is well known. The two concluding chapters provide detailed examples of the application to typical cases of the analytical processes under discussion.

The appearance of such a book emphasises in a very remarkable manner the facilities for monograph production offered by German publishers, and concurrently illustrates the difference in treatment adopted by Continental and by Anglo-Saxon authors. Van der Haar's treatise must be accepted as faithful and complete when viewed as a record of facts, yet it is useful only to a small number of specialists, whilst E. F. Armstrong's "Simple Carbohydrates and the Glucosides," dealing with identical materials, appeals alike to students, specialists, and general practitioners of organic chemistry. One presents the bones for sixty-four marks, the other makes a personal introduction to a living body for twelve shillings.

The present work is admirably produced, and remarkably free from errors, most of which are conveniently overtaken in a list of corrections on the concluding page; but the absence of a subject-index is to be regretted. M. O. F.

Our Bookshelf.

Solubilities of Inorganic and Organic Substances. By Dr. Atherton Seidell. Second edition, enlarged and thoroughly revised. Pp. xxii+845. (London: Crosby Lockwood and Son; New York: D. Van Nostrand Co., 1920.) Price 45*s*. net.

SOLUBILITY determinations are often incidental to other investigations, and are, consequently, not indicated in the title of the original paper, or included in the index of the journal in which they appear. For this reason such data are often difficult to locate, and Dr. Seidell's well-known compilation is a valuable contribution to chemical literature.

Originally published in 1907, the work was the first successful attempt to present a critical survey of available quantitative solubility data and to select from the discordant results of different observers the most trustworthy values for any given substance. An enormous mass of solubility data has since accumulated, and the present much enlarged edition, which brings the subject-matter up to 1918, is certain of a warm welcome. The nomenclature, especially of organic substances, has been revised, and the scope of the work extended to include freezing- or melting-point data for binary and ternary systems.

The author has endeavoured to maintain "unremitting vigilance" to avoid errors, but attention may be directed to an unfortunate lapse in the second table on p. 518, where an error has been made in converting milligram-molecules into grams, and where KOH ought to be K_2O. All the values in the fourth and fifth columns are wrong. In some cases the author has detected errors in calculation of original results, and indicates the necessary corrections—*e.g.* under strontium formate (p. 681) and ammonium perchlorate (p. 43).

New features in the present edition include a detailed explanation of the tables for the guidance of those more or less unfamiliar with the usual tabular methods of expressing such data; a chapter describing some of the methods used for the accurate determination of solubilities, with excellent diagrams; and an author index, with references to all the original papers consulted.

S. A. K.

Small Holding and Irrigation: The New Form of Settlement in Palestine. By Dr. S. E. Soskin. Pp. 63. (London: George Allen and Unwin, Ltd., 1920.) Price 2*s*. net.

THIS small publication has been issued by the Zionist Organisation in the interests of agricultural and horticultural settlements in Palestine. Intensive gardening is the main theme, and the application of the water resources of the country to the development of vegeculture, as a primary industry, is strongly urged. "The intensive utilisation of the irrigable areas for vegetable and fruit plantations should not come at the end of a period of development of years and decades, but at the beginning of our work of reconstruction in Palestine." After the preface and introduction, the subject is elaborated in four chapters. The first chapter deals with the general principles of irrigation in Palestine, as also does the introduction, contrasting the climatic conditions with those which obtain elsewhere in tropical and sub-tropical regions. It is claimed that artificial irrigation will work wonders, rendering two, three, and even four crops a season a possibility. The second chapter discusses the features of intensive gardening and the utilisation of manures and other adjuncts to cultivation. Tomato growing is represented as a promising venture, as also is the cultivation of the banana. The next chapter, headed "A Garden City," indicates the opportunities for, and the value of, co-operative effort. The last chapter is a brief, final word on the essential preparations for the first settlements under the scheme.

Every Boy's Book of Geology: An Introductory Guide to the Study of the Rocks, Minerals, and Fossils of the British Isles. By Dr. Arthur E. Trueman and W. Percival Westell. Pp. 315. (London: R.T.S., n.d.) Price 6*s.* net.

THIS is a good introduction to geology, lucidly written and thoroughly up-to-date. The illustrations are simple, and are line-sketches only, but they convey their meaning. The authors rightly presume that those who read their chapters are prepared to be interested in the subject. There is no talking round about, in the hope of disguising what is going to be a lesson rather than a mere encouragement to learn. There is not much room for originality in the selection of the facts put forward; but the merit of this book lies in its accuracy and simplicity of statement. The old discussions that were at one time held to be necessary in every text-book, such as the evidence of earth-movement afforded by coral-reefs, are wisely left to larger treatises. The suggestions we have to make are merely trivial. It seems cumbrous nowadays to write the names of chemical elements and compounds with capital letters. On pp. 32 and 131 felspars and beryl are respectively described as of "very complex" composition; but, when the reader has learnt the use of chemical symbols, he will not find matters so alarming. On p. 33 "twinning" should be omitted or more exactly defined. Potash is as important in biotite as in muscovite (p. 35). It is not at all necessary for a limestone to be melted before passing into crystalline marble (p. 73). We are glad to note the recommendation of a bicycle to the young explorer in our islands. Fossils do not necessarily lie on the tracks of chars-à-bancs.

G. A. J. C.

Education for Self-realisation and Social Service. By Frank Watts. (The New Humanist Series.) Pp. xii+275. (London: University of London Press, Ltd., 1920.) Price 7*s.* 6*d.* net.

UNDER the title of "The New Humanist Series," with Mr. Benchara Branford as editor, the University of London Press is projecting a series of volumes in which "the most modern advances of knowledge will be sought in order to fructify the many and varied fields of education. The subjects of the curriculum will be discussed by experts not too far removed by time from their own school years." These will be preceded by general volumes, of which the present book is the first. The treatment is adequate, and may be profitably compared with that of Prof. Nunn in the opening volume of another educational series. Without neglecting the rather intellectualistic psychology on which teachers of an earlier generation were brought up, it seeks the foundations of character and conduct in the innate tendencies to which the child is heir from an evolutionary past. The work of psycho-analysts is laid under contribution, and some of their terms, such as "sublimation," are adopted or adapted. In a diagrammatic "Tree of Human Development," from roots in *l'élan vital,* two main stems, the nutritive *horme* and the distributive *libido,* arise, and from the latter are derived the flower and fruitage of the sublimated will or *eros.* There are many practical suggestions which will be found of value by teachers.

Utilisation des Algues Marines. By Prof. Camille Sauvageau. (Encyclopédie Scientifique: Bibliothèque de Botanique Appliquée.) Pp. vi+394. (Paris: Octave Doin, 1920.) Price 7.50 francs.

MANY possible uses of seaweeds are described in Prof. Sauvageau's excellent treatise—agricultural, industrial, alimentary, therapeutic. Their value as manure is great, but is limited by cost of carriage. Among industrial uses of brown algæ may be mentioned the kelp industries, formerly so profitable as the source of soda, and still yielding potash, iodine, and bromine. Algin, norgin, and tangin are patented products used as dressings for textiles, etc., as also are the mucilages extracted from red algæ. During the war acetone was produced on a large scale by fermentation of brown algæ in American munition factories, and used as a solvent for gun-cotton, etc. By a similar fermentation, alcohol can be manufactured in quantity for motor fuel. The Germans devised a "fuse" of Laminaria to explode shells falling into water. Algæ, though commonly eaten in Japan, China, and elsewhere, are really valueless as human food, but for domestic animals they have for ages been used as winter fodder. During the war French horses were successfully fed on a partial diet of algæ; the new food, though quite indigestible at first, gradually became assimilable, probably through the adjuvant action of bacteria or yeasts. Prof. Sauvageau's monograph is a welcome acquisition.

Letters of Travel. (1892–1913.) By Rudyard Kipling. Pp. vi+284. (London: Macmillan and Co., Ltd., 1920.) Price 7*s.* 6*d.* net.

WITH his faculty for noting the little significant things, as well as the big and striking things, Mr. Rudyard Kipling gives us wonderful pictures of life in America, Canada, and Egypt. Some of the letters are old—they are reprinted from periodical publications—but all are fresh in human interest, because they dwell on big, essential problems. The volume is Kipling at his best, without the "tobacco and blood" in which he often indulges, and with his wealth of illustration and telling incidents of travel. These short chapters give truer impressions of the lands they treat of than all the ponderous volumes of painstaking travellers, collecting facts and arranging statistics.

Slide Rules and How to Use Them. By T. Jackson. Pp. 30. (London: Chapman and Hall, Ltd.) Price 1*s.* 6*d.* net.

THE principles upon which the construction of slide rules depend are described in this pamphlet, and numerous examples are given of the methods of use of such mechanical aids to calculation.

Electric Switch and Controlling Gear: A Handbook on the Design, Manufacture, and Use of Switchgear and Switchboards in Central Stations, Factories, and Mines. By Dr. C. C. Garrard. Second edition, revised and enlarged. Pp. xxii+654. (London: Benn Brothers, Ltd., 1920.) Price 25*s*. net.

No considerable alterations have been made in this work since the first edition was reviewed in NATURE of March 1, 1917. Slight modifications have been effected, and recent data in connection with high-tension gear, lightning arresters, etc., added. Two new sections, one dealing with the standardisation of switchgear and the other with automatic contactor switches, have also been inserted.

Milk Testing: A Simple Practical Handbook for Dairy Farmers, Estate Agents, Creamery Managers, Milk Distributors, and Consumers. By C. W. Walker-Tisdale. Second revised edition. Pp. 90. (London: J. North, *Dairy World* Office, 1920.) Price 3*s*. 6*d*. net.

THE recognition of the value and importance of "milk recording" is making it increasingly necessary that simple but trustworthy methods of testing milk should be published for the use of practical farmers. This need is well met by the present edition of Mr. Walker-Tisdale's little book, which has been enlarged and revised since the second edition was noticed in NATURE of August 10, 1911.

Letters to the Editor.

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The Energy of Cyclones.

THERE can be no doubt, I suppose, that solar and terrestrial radiation are ultimately responsible for the kinetic energy of the winds. The doubts expressed by Mr. R. M. Deeley in NATURE of November 11 and by Mr. W. H. Dines in the issue of November 18 can refer only to the details of the phenomena consequent on the process of transformation of the energy. The first stage is obviously the storage of energy in the potential form of air charged with heat and moisture at the surface or lower levels and cooled by radiation at high levels, especially in the polar regions, as on the plateau of Greenland or on that of the Antarctic continent, or on the sunless slopes of the Himalaya. Equally without doubt the next step is convection, the greater part of which is indicated here and there by falling rain or snow. Measurements of rainfall assure us that there is no lack of energy available for violent winds if the heat-engine is at all efficient.

The general effect of the process of convection is the development of a vast circulation in the upper regions of the atmosphere from west to east round the poles, which has its counterpart in the normal distribution of pressure at corresponding levels. That is probably most pronounced at a level of 8 km., because at that level density is equal all over the globe at all seasons of the year. Above that level, up to the level of equal pressure at 20 km. of which Mr. Dines writes, there is, on the average, a gradient of density from the equator to the pole, and below the level of 8 km. a gradient of density in the opposite direction. The layer of maximum average velocity is above the layer of maximum pressure-gradient on account of the diminution of density with height.

Below the level of 8 km. the distribution of pressure is affected by the gradient of density in a very irregular manner, because the distribution of land and water is irregular. The net result at the surface is the complicated distribution of average pressure which we find in the maps of normals for sea-level.

The maintenance of the average general circulation from west to east in the higher levels is due to the gradual convergence towards the polar areas from which the cooled air flows. That must obviously be balanced by a corresponding flow towards the equator, and as poleward flowing entails a westerly circulation, so flowing towards the equator entails an easterly one. We must, therefore, find room in the system for a body of air flowing from the east comparable at least with the circulation from the west. We find such a body of air in the great easterly circulation of the intertropical regions, which is naturally stowed away over the equator as far as possible from the centres of the two polar demi-hemispheres of influence of pressure-gradient.

These great circulations, easterly and westerly, form a normal "groundwork" of all atmospheric motion; and when Mr. Deeley and Mr. Dines write of the energy of cyclones, they are not concerned, I think, with the energy of the general circulation of the upper levels which I have described, but with the minor circulations which represent the perturbations of the major circulation.

I think myself that the convection of warm, moist air, combined with the vagaries of temperature in the lower layers, will, in the end, prove to be sufficient to explain the energy of cyclonic air-currents—whether directly or as the secondary effect of current-differences, I cannot say. Probably, in order to get a correct view of the perturbations, we ought to subtract vectorially from the observed winds the local motion of the normal circulation, or else accustom ourselves more than we do to the theoretical combination of local circulation with a general circulation.

There are four other aspects of the problem upon which we are at present almost uninformed. The first is the locality where the cyclone, which is the subject of study, was generated; just as the cyclone itself is a perturbation of the general circulation, so what we see going on over our heads is the perturbation of a cyclone which may have originated in the general circulation thousands of miles away. A cyclone is a more or less stable dynamical system which certainly travels, but changes as it travels. The second aspect is the variation of velocity of the wind with height in the general circulation and in the cyclonic area itself. The third, which is closely connected with the second, is the trajectory of convected air. This could be calculated if we knew the point from which it started and the variation with height of the current which carried it. One often reads of convected air rising *vertically*, but we know that the actual trajectories of a pilot-balloon are of very various shapes, seldom vertical, and the balloon may part company from the air which supported it at the start by a distance measured in tens of kilometres. Air in convection rises very slowly. If we set its vertical velocity at one-hundredth of that of a pilot-balloon, the convected air may be thousands of kilometres from the starting point before its upward journey is finished, and its path may be very complicated. It is possible that this conception of the slow, gradual ascent of air may have a bearing upon the cloud-formation associated with a coming cyclone, but the subject is too long for a letter.

The fourth aspect is the behaviour of the convected air with regard to its environment. The slowness of its rate of ascent is dependent largely upon the development of eddies and consequent dilution of its mass with the cooler environment. This cannot of itself arrest the upward motion, though it delays it, and, consequently, when the convected air has arrived at its ultimate level it will have carried with it some of the air which formed its environment on the way. Hence the rising air will have "evicted" a certain amount of air by its passage.

The importance of combining these aspects is at once apparent if we consider that convection in still air would simply mean a readjustment of the mass in the vertical. The potentially warm air would be at the top instead of at the bottom, and the effect of a completed process of convection would be that pressure would rise within the area of operations. But if the risen air were delivered into a rapidly moving current at the top, the air which it had "evicted" from the environment on its way would be lost to the column, and when the process was completed the air would close in from the top, the bottom, and the sides. If there were any relative motion to begin with—and there is always some—closing in from the sides must develop cyclonic circulation with a cold core. Closing in from the bottom with air colder and drier than that which began the convection would stop on account of dynamical cooling, and closing in from the top means the settling down of the air of the stratosphere and a consequent low tropopause with a column of air above it warmer than its environment.

These conditions describe what the late Lord Rayleigh postulated for superposing a vortex on a current with relative velocity of its parts. They also agree with what Mr. Dines describes as the results of his examination of actual cyclonic conditions in England. And this view of the procedure is borne out by the examination of tropical cyclones. We can form legitimate inferences from the pressure records of these visitations because the normal conditions of the localities where they occur are extremely regular. We can see by an inspection of the graph of pressure that the region covered by a cyclone has simply lost a certain part of the air which it normally possesses. In one example I estimated the loss as equivalent to 40,000 cubic km. at sea-level. Beyond all doubt or question air had gone; it was not piled up in anticyclones fore and aft, as we used to think the convected air of our cyclones must be; it was gone clean away. I suspect that it travelled away in some upper current until slowed down over the tropical anticyclone of some ocean. The story will not be complete until that surmise is verified or the correct account substituted. Hence, for the time being, I am as curious about the life-history of convective air-currents as I was twenty years ago about that of surface air-currents.

In any case, it seems to me certain that, because it carries away part of the air which it meets on its path, convection, wherever it occurs, must entail convergence, and therefore, except at the equator, it must give rise to a cyclonic circulation which may be transient or, if circumstances are favourable, permanent. The function of the stratosphere seems to be not constructive, but conservative and registrative. It protects the energy from being dissipated by "filling up," because the descent of its isothermal air is arrested by the adiabatic rise of temperature. That is, indeed, the common function of all "decks" or lids in the atmosphere, of which the stratosphere is the chief. At the same time, for an observer the stratosphere registers the locality of low pressure by the lowness of the tropopause and the relative warmth of the air column above it. It seems to be a law for the general circulation and for local circulations that as pressure diminishes in the troposphere the tropopause is lowered and the temperature of the columns above it rises.

Consequently, my view at the present time is that the energy of a cyclone is due originally to convection in a region with a suitable law of variation of velocity with height; it is guarded at the top by the isothermal condition of the stratosphere, and on the sides by the balance of pressure and rotation. It is open to slow attack at the bottom on account of the friction of its winds with the surface, and unless its energy can be maintained by additional convection it must perish. I do not think that a travelling cyclone carries its supply of rain for long distances; it probably manufactures it out of the material in the lowest levels which it has to pass over. But it uses the energy so supplied first to form a secondary, and afterwards to absorb it or to be absorbed by it.

NAPIER SHAW.

Imperial College of Science and Technology, S.W.7.

IT is a well-known hydrodynamical result that, in the absence of any external stabilising influence, any surface of discontinuity of velocity in a fluid must be unstable. The effect of this instability is seen in the eddies produced in a millpond, at the margin of the entering stream. A sufficiently rapid shearing, without actual discontinuity, will produce the same effect. Most atmospheric eddies are developed in this way. In the case of differences of velocity between different masses of air at the same level, gravity is not directly available to damp any eddies that may be produced, and hence it does not seem likely to be difficult to account for eddies with their axes vertical.

Thus the origin of cyclones may well be explained on the lines suggested in Mr. W. H. Dines's letter in NATURE of November 18. It is rather more difficult to see what determines the size and intensity to which they grow. Ground friction must play its part; also, where the warm stream on the south side bulges northward, it must do so to some extent over the top of the cold air already there, and this arrangement makes for stability, and when sufficiently developed must prevent the further growth of the disturbance.

The speed of translation of the cyclone on this theory should be the mean of the velocities of the two currents, which is usually about correct. The geostrophic condition must also hold approximately, otherwise the disturbance would spread out with nearly the velocity of sound and disappear. What is not easy to see, however, is why the isobars tend to become more or less circular instead of wavy.

HAROLD JEFFREYS.

Meteorological Office, South Kensington.

I SHOULD like to express my agreement with Mr. W. H. Dines's view (NATURE, November 18, p. 375) regarding the origin of the *initial* difference of pressure which leads to the development, under the influence of the earth's rotation, of cyclonic circulation, and to state that I have often suggested that this initial disturbance may have a mechanical origin (see Quart. Journ. Roy. Meteor. Soc., vol. xliii., 1917, p. 27). At the same time it seems that one cannot, on many grounds, ignore the effect of temperature contrasts as a contributing factor in the further development and maintenance of storm energy.

To take the very fact which Mr. Dines cites, namely, the exceptional storminess of the Atlantic to the north-west of Scotland. This region is, in a most conspicuous degree, stormier in the winter months than in the summer, and it is almost one of the canons of physical geography that the excessive development of storm-energy during the cold season is favoured by the great contrast in temperature between the frostbound continents and the warm Atlantic, the individual cyclonic systems breeding not so actively over the land areas, where the general pressure is high, as over the oceanic areas, where the general pressure is low. On the other hand, during the warm season—when the temperature gradient between the oceans and the continents is reversed, but is much less steep than the winter gradient—cyclonic energy in the North Atlantic is far less powerful, whilst over the sun-heated continents storm-energy takes the form, not of extensive wind-systems, but of localised convectional thunder-systems. Furthermore, in the southern ocean, between 40° and 60° S., where there are no disturbing land masses, there does not appear, judging from the reports of navigators, to be such conspicuous seasonal difference in storminess, and this is borne out by statistics available for the Falkland Islands (Meteor. Office Geophys. Mem., No. 15). L. C. W. BONACINA.

November 19.

SIR OLIVER LODGE'S suggestion and mine in NATURE of November 25 are not contradictory, but rather complementary. Work done by the alternate evaporation and condensation of moisture implies a thermodynamic cycle. Both air and aqueous vapour must, I think, play the part of working substance.

J. R. COTTER.

Trinity College, Dublin, November 26.

Luminosity by Attrition.

ALLOW me to add to the list of minerals showing this phenomenon one which I have already given in my book "Diversions of a Naturalist." It is that of corundum. I found that water-worn pebbles of corundum (so identified in the department of minerals of the Natural History Museum) gave flashes of light when rubbed together, but required for this result a heavier pressure than do pebbles of silica. The same odour as that observed when silica is used was produced.

I may also repeat here what I have stated in my book, that a spectroscopic examination of the luminous flashes of quartz pebbles gave a continuous spectrum and no detached bright lines.

E. RAY LANKESTER.

November 28.

SOME ten years ago when grinding down a thin slice of limestone under water I was surprised to find that the operation was accompanied by faint flashes of light which seemed to issue from certain spots of superior hardness; on examining the slice under the microscope it was found that these spots consisted of quartz. This led me to devise an apparatus by which the luminescence could be continuously produced and so rendered a subject for precise observation. The substance to be examined was attached to the free end of a hinged bar and adjusted so that it rested against the edge of an emery, or, still better, a carborundum wheel which was rotated by an electric motor. Of some forty minerals experimented upon no fewer than eighteen emitted light while being ground. Those that did not included all the sulphides which were examined, viz. zinc blende, cinnabar, antimonite, galena, copper pyrites, and arsenical pyrites. Iron pyrites, of course, yielded sparks, but these were not accompanied by tribo-luminescence. Almost all the silicates emitted light, *e.g.* orthoclase, labradorite, idocrase, garnet, tourmaline (one variety, another did not), epidote, zircon, topaz, and glass; several oxides, *e.g.* corundum, magnetite, hæmatite, cassiterite, quartz, and flint; light was also obtained from wavellite, apatite, celestine, and barytes. But the most remarkable results were obtained from fluorspar; all the varieties of this mineral which were examined gave light, but one in particular, distinguished by its green colour, emitted blue light, not only in great quantity, but also of such persistency that the whole periphery of the wheel was alive with it.

Curiously enough, no electrical phenomena were observed in any case; an electroscope, possibly not a very sensitive one, gave no signs even when fully exposed to the current of dust driven off during grinding.

The light emitted was in most cases white, but often coloured reddish or yellowish, and in a few instances bluish. It would be quite possible to examine (as I did) the light with a spectroscope, and after some preliminary trials I planned apparatus for photographing the spectrum. The outbreak of the war, however, put a stop to my experiments, and I have not yet had time to resume them.

November 25. W. J. SOLLAS.

Stellar "Magnitudes."

MAY I ask whether it is not time to overhaul and improve the conventional specification of stellar magnitudes?

When first introduced, on the basis of ordinal numbers, the plan was natural enough; a third magnitude was naturally inferior to a first, and a group of some twenty stars could be considered as of the first magnitude.

But when it was found possible to measure and specify magnitudes with numerical accuracy—by instrumental means not, I confess, fully known to me—so that a Variable could be said to decrease from 2·14 to 2·56, the cardinal number specification looked inverted. Moreover, magnitudes less than unity became necessary for the brighter stars, and a sufficiently bright star would presumably have the magnitude 0; a nova, for instance, might blaze up from magnitude 12 to magnitude zero, or even become of negative brightness at the height of its career. Indeed, I gather that a more recent system, of what are called "absolute magnitudes," really does involve negative numbers.

Would it not be well to reconsider the convention and devise something more convenient?

OLIVER LODGE.

Higher Forestry Education for the Empire.

THE question has been recently raised by the Government of India as to the advisability of either training the probationers for the Indian Forest Service entirely in India or confining the training to one centre in this country. The question has come to the front owing to the changes to be introduced in the administration of India, under which a larger proportion of Indians will enter the Indian Forest Service in the future, it being therefore considered desirable to train the European and Indian probationers all together. The professional forestry opinion of Indian officials, with which Prof. Troup and I agree, would appear to be unanimous in condemning the possibility of training the forest probationers in India owing to the fact that the Indian forests are, as yet, very far from having reached the standard necessary to provide students with the full practical object-lessons which are to be seen only in forest areas which have been under scientific management through one or two rotations of the crops.

The alternative suggestion is to revert to the one centre at home, which was given up when the forestry branch at Coopers Hill was closed down in 1905. This question of one centre was considered at the Empire Forestry Conference held in July last in London. The Forestry Commissioners suggested that a new centre should be created apart from the universities, and that both Indian forest probationers and the Colonial and Dominion probationers required for the Empire should be trained at the centre. It was suggested that the probationers should be selected from graduates in natural or pure science at the universities, and that these probationers should then be sent to the centre to undertake a two years' course in forestry and the applied science subjects. The conference voted in favour of this proposal. The situation of the centre, whether at one university or apart from the universities, was left in abeyance. The Indian Government representatives wished the centre to be at one university at which a forestry college should be erected for the probationers, the latter otherwise taking advantage of the university courses, laboratories, and so forth.

At the present moment the three Universities of Oxford, Cambridge, and Edinburgh are recognised by the India and Colonial Offices as qualified to train their forest probationers. The suggestion to confine the training in the future to one university would be, therefore, subsidising one university as against the other two, thus involving the waste of the capital sunk by these universities in placing their forestry schools in an efficient position. To carry out the one university centre idea it would be necessary to obtain considerable grants of money from the Indian and Colonial Governments, and it is doubtful whether one university could be thus subsidised by the Government at the expense of the others. The suggested alternative is the one centre apart from the universities.

At the end of September last the Forestry Commissioners called a meeting of the heads of the schools giving forestry training in this country.

In the discussion on the one centre proposal the heads of the forestry schools of Oxford, Cambridge, and Edinburgh were unanimous in condemning the one centre away from the university, considering that it would introduce a rigid type of teaching which would give rise to a forest officer with a narrow outlook. It would also be difficult to get first-class teachers to take up appointments in an isolated centre. The cost of the new buildings and their equipment and the outlay on salaries would also be a very heavy charge. The period of three years for the science degree and two years for the later training in forestry was also deemed too long, involving the probationers joining the Services at an unnecessarily advanced age. They were also of opinion that the complaints of the Indian Government as to the inadequacy of the training of some of their forest officers were due to the present method of selection, many probationers being selected before they had any training in forestry or knew anything of the life of a forester. It is common knowledge at the university centres training for forestry that men, finding they have no taste for the forestry subjects, change over to another side of the university at the end of their first year and while there is still time to do so. The selected forest probationer with a Government training grant is not often in a financial position to enable him to throw up his grant. Yet the proposal for the single centre away from the university is based on the continuance of this selection system. The heads of the university departments were also strongly in favour of the higher forestry education being given at the university, as the men, European and Indian alike, profited greatly by mixing with others training in other branches.

It became apparent at the Empire Forestry Conference that many of the delegates had only a superficial acquaintance with the latter-day developments in forestry education at the three Universities, which, to a great extent, have been the result of the work of the last decade.

With the view of providing for the India Office requirements that *esprit de corps* should be engendered amongst its probationers by living together, and also the practical needs of the future forest officer, which are now greater than they were, I made the following suggestion:—That the forestry probationers for India and the Home and Colonial Services should be selected from the men who had obtained a degree or diploma in forestry at the universities, and that these selected probationers should then be sent for a period of six months or a year to the new Empire Research Institute, which the Empire Forestry Conference delegates suggested should be inaugurated in this country. The probationers could be given such specialised courses as were required at this centre with a very small extra expense. The Indian probationers would thus live together during part of their training, and that *esprit de corps* required by the Indian Government would be engendered.

In the Memorandum of the Education Committee of the Conference (White Paper, Cmd. 865, p. 15) it was stated that my proposal *in re* extra specialised courses was "a tacit admission that existing courses were capable of extension with advantage." I have shown that time will not permit of an extension of the curriculum during the three years required for the forestry degree. The question of extending the degree course to four years has been under consideration at Edinburgh. The Indian Government delegates have stated that the forest officers of the future would be the *corps d'élite* of the Indian Forest Service. I fully agree with this view. To train the men to this standard will require extra specialised or advanced courses, and these can be given either at the universities or, as in my suggestion to meet the views of the Indian Government, at the Empire Research Institute.

Apart from India, the suggestion of the one centre is made on the ground that it will prove cheaper owing to the large demand for grants in aid of forestry education which have been made to the Forestry Commissioners; but in this matter of the higher training for the forest officer only three universities in this country are at present in question.

It should be possible to find out what additional funds the three universities require to maintain their schools in the highest possible efficiency, and this amount, combined with the additional sum required for the extra training of the probationers at the Empire Research Institute, would be likely to be far below the amount, to which India and the Colonial Office would have largely to contribute, which would be required to create a new isolated centre apart from the universities.

The decision on this point of the future of the higher forestry training is a momentous one, since it involves no less than the future correct management of the majority of the forests of the Empire.

E. P. STEBBING.

University of Edinburgh, October 29.

British Laboratory and Scientific Glassware.

I HAVE read with much interest the letters in NATURE of November 4 from Prof. Bayliss and Mr. Frank Wood on the subject of British glassware, and I think the whole truth lies, perhaps, between the two opinions put forward. As a manufacturer of scientific apparatus, and primarily of X-ray tubes, I have had probably as trying an experience of glass as any manufacturer since 1914.

It is well known, I presume, that prior to the war the whole of the glass bulbs and tubing used in the manufacture of X-ray tubes came from Germany, and the quality was undoubtedly very fine indeed. Since 1914 we have been obliged to depend upon glass of French, American, and English manufacture. Although by no means without merit, the products of the two first-named countries were discarded directly the English makers were in a position to give us anything at all adequate to work with, and since 1916 I think we have not used any glass whatever other than that made in this country.

At the present time the position is that a glass reasonably good for our purpose is made by at least two British firms. It works well in the flame and preserves a good appearance, but it is impossible to say that it has reached the high standard set by the German product. So far as the purchasers of the finished instrument are concerned they are not affected, because the imperfections of the British glass, where they exist, manifest themselves during the manufacture of the complete X-ray tube, and the difficulties, therefore, are entirely connected with manufacture, and not with the efficiency of the working of the apparatus which is being constructed.

It has seemed to me for a long time past to be a matter for regret that the British manufacturers could not make those small final improvements which would give us exactly the material we require instead of, as at present, stopping a little short of the ideal.

I believe there is no particular difficulty at the moment in obtaining supplies of glass from Germany, but up to now I have resisted every temptation to do this, partly on general sentimental grounds, but largely because of the enormous amount of trouble which has been taken by the two firms of which I spoke in order to produce a glass suitable for X-ray purposes. I am sure that from start to finish the profit on this undertaking must have been negligible, and there have been endless experiments and a very large amount of waste, the cost of which has fallen chiefly on the glass manufacturers themselves.

For this reason I feel that every endeavour should be made to place the British glassmakers in a position whereby they could continue to produce these special glasses, the demand for which is comparatively small, but which are, nevertheless, of the very greatest importance to scientific workers in this country. Those firms engaged in my particular branch of the electro-medical industry are always only too ready to co-operate in every possible way with the glass houses in order to secure in this country absolute independence in the matter of the supply of material.

CUTHBERT ANDREWS.

47 Red Lion Street, High Holborn,
London, W.C.1, November 25.

Heredity.

IN his letter to NATURE of November 25 Sir Archdall Reid has ably stated some fundamental biological truths concerning heredity, and with many of his statements I believe all biologists would agree. From the developmental point of view there is certainly a sense in which all characters are alike, arising as the result of the interplay of the germ and its environment, nature and nurture. In this limited sense it is doubtless beside the mark to inquire whether nature or nurture is more important, seeing that both are essential elements in any development at all. From this point of view it may be true, to cite Sir Archdall Reid's example, that there is no fundamental difference between the head and the scar; both may be in one sense germinal, and in another acquired.

But this does not go to the root of the matter, as may be most readily pointed out by referring to the latter part of the letter in NATURE. Sir Archdall Reid says: "The sole antecedent of non-inheritance is variation." The statement is true, of course, but he goes on to assume tacitly that all variations are in one category. Sir Archdall Reid recognises the fact, which Weismann emphasised, that "heritage travels down the germ-tract," and draws the "*necessary* [his italics] inference from this" that all characters of the individual are "innate, acquired, and inheritable in exactly the same sense and degree." But this is surely a *petitio principii*, for while all inherited characters may come to travel down the germ-tract, it does not follow that they all originated as variations in the germ-tract. It is surely legitimate to assume, until the contrary is proved, that new characters may arise (to use ordinary biological terms) as germinal variations or as impressed modifications of the soma which are not represented in the germ-tract. Indeed, this is the current distinction drawn between mutations and fluctuations. In the latter case the question will arise, whether the modified soma may ultimately affect the germ-plasm; in other words, whether a modification or an acquired character may come to be inherited by bringing about an alteration in the germ-plasm. This is surely a legitimate inquiry. If so, it implies the possibility that the "scar" might ultimately, having become germinal, appear without the specific stimulus that is now necessary to call it forth.

R. RUGGLES GATES.

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The Mechanics of Solidity.

UNDER this title Mr. J. Innes (NATURE, November 18) suggests, for the benefit of engineers, that coefficients of thermal expansion are fairly closely related to hardness. His list of thirty-eight materials ranging from diamond to indiarubber is given in order of thermal expansion. No definition of hardness is suggested, and the figures, taken from three tables of "hardness," are admittedly somewhat conflicting.

Hardness, I take it, is due in part to closeness of atomic packing. Diamond, the hardest substance known, possesses also the lowest known atomic volume, while potassium, the softest element on Mr. Innes's list, has by far the highest atomic volume, *i.e.* has the loosest atomic packing.

Diversities in hardness depend also on how far each substance tested is removed from its melting point. Taking fourteen elements from the list, and assuming tests for hardness were made at uniform temperature, the order of degree-distance below melting point comes out:—Diamond, iridium, platinum, iron, gold, copper, silver, aluminium, arsenic, antimony, lead, tin, bismuth, and sulphur.

The order of hardness is:—Diamond, iridium, platinum, iron, arsenic, antimony, gold-copper-silver, aluminium, tin, bismuth, and lead-sulphur. (It is probable that arsenic and antimony were tested in a crystalline state, in that respect differing from the three metals above and the four below them.)

The order of ascending coefficients of expansion is:—Diamond, arsenic, iridium, platinum, antimony, iron, bismuth, gold, copper, silver, tin, aluminium, lead, and sulphur. Here the agreement is not so close as before.

Doubtless coefficients of expansion themselves depend partly on how far the mean range of temperature from which they are calculated is removed from the melting point. For strict comparison, what are known as "corresponding temperatures" should be taken. If this is done for coefficients of expansion of gases, then the values become identical; with solids (or liquids) the coefficients would approach, but never reach, uniformity.

In practice engineers are bound to consider arbitrary temperatures which will affect their mixed materials, but a knowledge derived from comparison of physical properties at corresponding temperatures would enable them to predict special changes among the mixed material which would occur when temperatures rise or fall. REGINALD G. DURRANT.

University College, Reading.

The Hardening of Metals under Mechanical Treatment.

IT appears from an article by Mr. Ernest A. Smith in NATURE of November 18, p. 381, that the cause of the hardening of metals under mechanical treatment is still regarded as obscure.

May I suggest, for the consideration of research associations and others concerned, that all the phenomena of plastic deformation, including hardening by distortion, are aspects of what Osborne Reynolds has called "dilatancy," and that this twentieth century is no time for random empirical experiments conducted without either guiding principles or clearly defined objectives?

Reynolds has shown that the density of a granular solid must change when the solid is distorted. There is ample evidence that distortion alters the density of metals, and no very valid reason for assigning the accompanying alteration of "hardness" (and other properties) to anything but a change in the pattern of the grains, *i.e.* to dilatancy.

Systematic experimental investigation can scarcely fail to have far-reaching results, and may even bridge the gulf between mechanics and the more exact sciences. J. INNES.

12 Edward's Road, Whitley Bay, Northumberland, November 22.

Tube-dwelling Phase in the Development of the Lobster.

WHILST the development of the lobster from the Schizopod stage onward to an inch or a little more is fairly well known, the great rarity of the stages between that and 3 in. or 4 in. (second year) has often puzzled marine zoologists. For instance, only once in many years has a small lobster of about 4 in. been seen at St. Andrews, and this example was tossed amidst a vast quantity of débris on shore after a violent storm. Prof. Prince, Dominion Commissioner of Fisheries for Canada, and president-elect of the American Fisheries Society, who has inaugurated many important advances in scientific fisheries work, tells me that Prof. Knight, who has been investigating the subject, finds that "after the pelagic stage the young lobster appears to frequent shallow bays and make a definite burrow with two entrances, and it sits on guard at one, but if in danger escapes by the other. It is very quick in emerging, but Prof. Knight and his assistant got 200 to 300 in a bay in Prince Edward Island. Now we know the reason of our failing to capture these very small lobsters from $1\frac{1}{2}$ in. to 3 in. long. The dredge cannot secure them, yet they must occur in countless millions in our Canadian bays, since many more than 100,000,000 adults are taken in our waters for canning and the live-lobster trade in good years." Thus the rarity of the little lobsters of the stage indicated is explained.

It is interesting that the adult, as shown by Dr. H. C. Williamson, of the Scottish Fishery Board's staff, has a similar fondness for cavities, which it searches for with its antennæ, and will even turn out a weaker neighbour and seize its shelter.

W. C. McINTOSH.

Contractile Vacuoles.

I HAVE just read W. Stempel's paper, "Ueber die Funktion der pulsierenden Vacuole," to which Prof. Bayliss kindly directed my attention in NATURE of November 18, p. 376. Stempel's idea as to how the contractile vacuole works appears to differ fundamentally from my conception of its mechanism. He regards it as a preformed organ of the cell, developed to eliminate the waste products of metabolism, these products being introduced into the vacuole by the radiating canals which he endows with peristaltic action. He further postulates the existence of non-return valves between these radiating canals and the vacuole, and also of one at the point of exit of the fluid to the exterior. He considers that the evacuation of the contents is effected by the osmotic pressure in the vacuole, opening the valve and thrusting out the fluid, by the surface tension of the extruded drop, and by the pressure of the protoplasm. He does not indicate that the elasticity of the protoplasm or its tenacity enters into the mechanism. My suggestion may be summed up in the much simpler statement that the contractile vacuole is a necessary development in the protoplasmic semi-permeable gel wherever sufficient soluble material accumulates, the radiating canals being formed by the elastic recovery of the gel after rupture. HENRY H. DIXON.

School of Botany, Trinity College, Dublin, November 20.

Leptocephalus of Conger in the Firth of Clyde.

IN a recent issue (vol. xii., No. 2, July, 1920) of the Journ. Mar. Biol. Assoc. Mr. E. Ford, in a "Note on a Leptocephalus Stage of the Conger," gives a "summary of captures around the British Isles." To the records there given, may I add two from the Firth of Clyde?

(1) July, 1907; off Keppel Pier; 3 fms.; length, 120 mm.; depth, excluding fins, 8 mm.; a distinct row of black spots along the lateral line. Taken from the stomach of a saithe (*Gadus virens*).

(2) March, 1908; Ardneil Bay, 10 fms.; taken from the stomach of a cod (*G. callarius*); too much digested to give any details. RICHARD ELMHIRST.

Marine Biological Station, Keppel, Millport.

Spiranthes autumnalis.

SIR HERBERT MAXWELL will, I am sure, allow me to make a little correction in his statement on p. 409 of NATURE of November 25; it was not Sir Joseph Hooker, but Sir William who in 1843 doubtfully described a solitary specimen of *Veronica tetragona* as a species of the coniferous genus Podocarpus. Oddly enough, the plant was correctly described from a flowering specimen in the same volume of Hooker's "Icones" on a later plate.

B. DAYDON JACKSON.

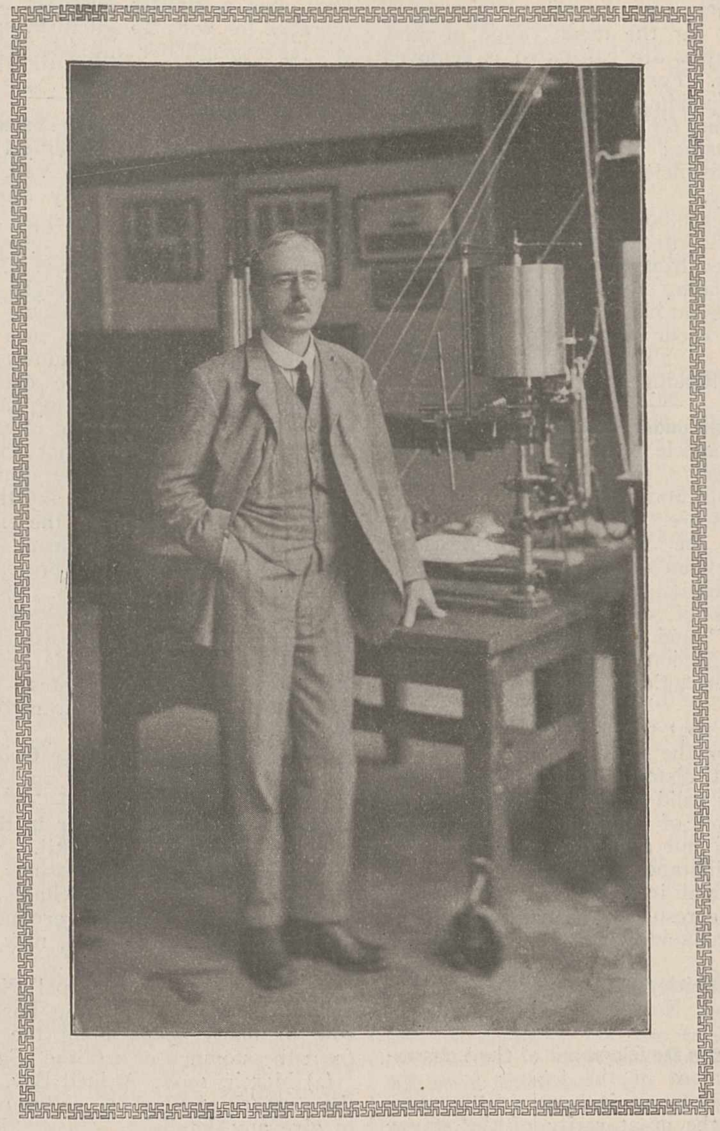
Linnean Society, Burlington House, London, W.1, November 26.

Prof. Sherrington's Work on the Nervous System.

By Dr. E. D. Adrian.

PROF. C. S. SHERRINGTON, who was elected president of the Royal Society at the anniversary meeting on November 30, is well known as the leading authority on the physiology of the central nervous system. The guiding principles of his researches are to be found in his book on "The Integrative Action of the Nervous System," based on the text of the Silliman lectures which he delivered in Yale University in 1906. This book gathers up the arguments of the most important of his papers on the physiology of the nervous system, and it is safe to say that no other book in any language has had such an immediate and profound effect on our conceptions of neurology.

The integrative function of the nervous system has long been recognised. An animal which has attained some degree of complexity is made up of different groups of cells forming the muscles, glands, supporting framework, etc., and each group is specially adapted to carry out certain functions. If these different cell groups are to work harmoniously together, their activities must be co-ordinated with one another and with the environment of the organism, so that a change in environment will cause a response in the animal as a whole, and not merely a series of disconnected responses in the different active tissues. This integration is carried out by the nervous system, which forms a complex network of nerve-cells and nerve-fibres connected, on one hand with the sense-organs, and on the other with the different muscles and glands. A disturbance of equilibrium initiated in the sense-organs travels rapidly along the sensory nerves to the central mass of nervous tissue in the spinal cord and brain. Every moment an immense number of impulses are entering the central nervous system from the million or more sensory fibres connected to the receptive organs, and other impulses are continually passing out down the motor nerves to the muscles. Any change in the environment will modify the inflow of sensory impulses and call for some change in the activity of the animal, and the whole function of the central nervous system consists in adjusting the passage of impulses through it so that the total effect produced by the outgoing impulses to the active tissues bears an appropriate relation to the total effect of the ingoing sensory impulses. The aim of the neurologist is, therefore, to discover the means by which this adjustment of the flow of impulses is carried out. There are, roughly, three main lines of research by which the problem has been approached. The first method consists in tracing the connections of the different fibres and cell groups in the nervous system, so as to map out the path by which the impulses must travel. The second attempts to find out the contribution made by different parts of the nervous system (*e.g.* the



Prof. Charles Scott Sherrington, President of the Royal Society.

cerebellum or the cortex) to the working of the system as a whole. Both methods have yielded information of great importance, but neither of them gives much prospect of explaining the intimate nature of the processes involved in nervous co-ordination. The third, a field relatively barren until Prof. Sherrington's work, consists in analysing the simplest activities of the nervous system by a detailed study of the reflexes.

A "simple reflex"—*i.e.* the performance of an isolated movement as the direct consequence of sensory stimulation—is generally regarded as the unit reaction of the nervous system, the behaviour of the animal being compounded out of a series of simple reflexes. But as this compounding of reflexes is the chief work of the nervous system it is naturally a difficult matter to isolate a single reaction out of the whole behaviour of the organism; indeed, in an animal which is intact we find that the response to a given stimulus may depend not only on that stimulus, but also on the total effect of all the sensory impulses which are entering the central nervous system or have entered it previously. Prof. Sherrington overcame this difficulty by isolating a part of the central nervous system, so that relatively few sensory impulses can reach it, and the reflex response to a given stimulus can be studied under approximately constant conditions. His method takes advantage of the fact that in the higher animals the great majority of sensory impulses are those which enter the brain from the special sense-organs in the head. These organs—the eye, ear, and nose—supply information about events happening at a distance, and it is on such information that the behaviour of the higher animals is largely based. For this reason the brain has come to be the most important part of the nervous system, and is in complete control of the more primitive spinal cord, which receives impulses only from sense-organs in the skin and in the interior of the body.

If the brain is cut off from the spinal cord, the latter is at first completely disorganised, but in a short time it recovers from the initial shock, and carries out simple movements of the limbs in response to stimulation of the skin or of the sensory nerve-fibres. These simple reflexes will now occur with almost mechanical regularity, because the spinal cord is isolated from the great mass of continually changing impulses which would otherwise reach it from the brain. In practice the animal is anæsthetised and the brain destroyed, usually by cutting off the entire head; as the breathing will cease, some form of artificial respiration must be employed, but with this the decapitated carcase will continue to show reflex movements for many hours. Prof. Sherrington has carried out a detailed analysis of certain of these spinal reflexes, in particular the scratching movements of the hind leg in response to irritation of the shoulder area, the withdrawal of the foot on the application of a painful stimulus, and various movements which form a part of the act of walking. He has studied also the "tonic" reflexes whereby the animal maintains a continued posture by the steady contraction of certain groups of muscles.

As a result of this method of research, he has been able to show the chief differences between conduction in the simple nerve-fibre and in the more complicated pathway through the central nervous system. He has shown how reflexes are compounded together so that two antagonistic muscles (*e.g.* the flexors and extensors of a limb) can never be called into play at the same moment, and how one reflex becomes fatigued and gives place to another so that the pattern of nervous conduction is continually changing and the behaviour of the animal varies even though the environment remains unaltered. The general principles of reflex action which Prof. Sherrington has formulated have had an immediate practical application to the problems of nervous disease and experimental psychology, and it is no exaggeration to say that his researches have opened up an entirely new chapter in the physiology of the central nervous system.

Industrial Research Associations.

IV.—The British Research Association for the Woollen and Worsted Industries.

By Arnold Frobisher.

The main object of the British Research Association for the Woollen and Worsted Industries is to promote co-operation amongst wool-using firms with the view of establishing a national scheme of research into the problems presented by the woollen and worsted industries. In the formation of the association, and in the matter of providing facilities for some work that has already been done, much assistance has been given by educational bodies, particularly by Leeds University and by the Bradford Technical College.

The scope of the work of the association includes the investigation of problems arising in all branches of the woollen and worsted industries—that is to say, the growth of wool, scouring, carbonising, carding, combing, spinning, weaving, hosiery manufacture, dyeing, bleaching, printing, finishing, and other auxiliary or related processes. As certain classes of "woollen" goods also contain substitute fibres, the investigation of these is also necessary.

One of the first duties of the council of the association has been to make a survey of the field of research which is likely to be beneficial to the industry. In this connection members of the association can be of great assistance in the framing of a thoroughly comprehensive scheme by making suggestions relating to that part of the industry with which they are intimately acquainted.

In addition to conducting the ordinary laboratory research work, provision has been made for entering into agreements with mills and works for carrying out any experiments on the manufacturing scale which have, or may, become necessary.

Considerable progress has been made towards the establishment by the association of a wool textile library, where literature relating to the industries is being indexed, abstracted, and arranged. In this connection it is hoped to work in close co-operation with the university and commercial libraries already in existence, so that there shall be a minimum of overlapping.

There is also being established a bureau of information, to which any member of the association can apply for assistance in the technical and other difficulties which he may encounter in his business. If the information necessary for the solution of his difficulty is available, it will be supplied to him; if this information is not available, the member will be able to rely on attempts being made to procure it.

Besides the scheme of co-operative research for the common good of members of the association, it is proposed to make provision for carrying on investigations at the request of individual members, at their own cost and for their own benefit. In such cases the work will be done under the supervision and control of the Director of Research, and fees will be charged to cover the cost of the investigation.

The association has purchased a large mansion in about four acres of ground, which is at present being converted into physical, chemical, and mechanical laboratories, with rooms specially adapted for photographic and photomicrographic work. A feature is being made of the possibility of modifying and improving testing machines and devices for fibres, yarns, fabrics, etc.

In the basement of the premises a room is being fitted up, the atmosphere of which can be automatically controlled as to temperature and humidity. The chamber is of sufficient size to enable experiments to be conducted within it under known and controllable conditions. At least two such rooms exist in the U.S.A. for use in testing paper and textiles, but, so far as is known, there are none in this country, apart from arrangements for *increasing* humidity. A small experimental plant is also being installed for the investigation of problems of scouring, milling, and finishing, and, as necessity arises, small-scale plants will be installed for other experiments.

As regards the programme of research, a number of "practical" problems have been formulated, among which may be mentioned the effect of "condition" (*i.e.* percentage of moisture), strength, finish, handle, waterproofing, efficiency and suitability of machinery, etc. For the solution of these problems a large amount of work is required on the ultimate properties, physical, mechanical, chemical, etc., of the fibre. Even for the commoner processes and reactions the information available is by no means complete or convenient. The early work of the association is bound, therefore, to include a great deal of former work by way of review and amplification. There are very many branches of the subject that have been worked at many times, but not completed. This particularly applies to the absence of micrographic and often of physical tests.

For example, some information is available on the swelling and elongation of fibres with water and reagents, on the manner in which the strength and elasticity of fibres are affected, and how they stiffen, soften, etc. The information at present available on those points is, however, neither sufficiently authoritative nor complete. Again, similar investigations will require to be extended to yarns, etc. Then there is the whole question of the effect of tension on the measuring and winding of yarn. Also, there is no accurate method of standardisation of qualities or descriptions in the trade, and the possibility of establishing accurate standards is to be investigated. Experiments have been going on for some time into the matter of the electrification of fibres during certain processes, and the better control of this factor would be of great commercial importance.

It is on the basis of such information as is indicated above that manufacturing processes ultimately depend. Whenever a problem in manufacturing arises, it is nearly always found that the investigation leads back to questions of a fundamental character.

Appointments of staff have already been made to cover the sections relating to physical, chemical, and mechanical problems. On the physics side an analysis will be undertaken of the ultimate physical conditions which distinguish wool from other fibres. This will lead up to a definition of the properties of any substitute. Many experiments will be made in the special humidity-controlled room, and tests carried out during and after the various processes through which the fibre passes before becoming finished fabric.

A wide field is opened up on questions of the effect on strength, elasticity, etc., of numerous reagents, and in this connection very many notes have been made of the action of various reagents, which require further investigation. It is intended to examine the many proposals for the preparation of wool substitutes, and to compare the actual properties of the resulting products.

Attention will also have to be paid to the elimination of waste in the various processes and to the recovery of grease, soaps, etc. This might be done more by way of demonstration than by investigation, as many processes are known but are not in regular use. Comparisons will be made of the detergent power of soaps and other detergents, and also of the soaps of various fats as between themselves.

On the biological side it is emphasised that there is much scope for improving the quality of British wools, and several conferences have been held at which all interested bodies and classes, including the Boards of Agriculture, sheep-breeders' associations, flock-owners, university professors, and manufacturers, were represented. It was generally agreed that by the method of selective breeding and the establishment of new crosses, etc., an improvement in wool, without loss of mutton characters, is feasible. Experiments directed to this end are already in hand in several quarters, and it is hoped that with the co-operation of the Boards and breeders substantial advances will be made.

The management of shows and individual prize-givers can also do an enormous amount to further the objects in view. It is suggested that the services of a wool expert should be retained for the more important shows, and that, in all classes where such is possible, points should be given for the wool. This expert should direct attention to its merits and defects for manufacturing.

Much work might be done in the microscopic examination of fibres and in the actual carrying-out of small- and large-scale breeding experiments, with the object of improving the wool, particularly of British breeds.

The question of large-scale experiments is not being neglected, and a site has already been purchased upon which it is proposed to build an experimental factory for investigating under actual commercial conditions, on a manufacturing scale, the many problems connected with woollen carding and spinning. This factory will be equipped with the most up-to-date machinery and staffed with the most expert labour available, with the view of conducting experiments and investigating variations of present-day methods. A well-qualified man of science will be engaged in the factory to observe conditions and keep records, and any variations in method or investigations with a view to improvements will be under his supervision. Individuals will be allowed to use the machinery for private investigations at a fee to cover the working costs. Members have also been of great assistance in allowing experiments to be made in their factories. On these questions, and, in fact, on all other topics upon which it is considered expedient, publications will be prepared, and several have already been issued.

It is clear that the work of this association overlaps or dovetails with that of other bodies in many directions. Co-operation is a welcome necessity, and has been given or offered by several Government Departments, universities, technical schools, the Industrial Fatigue Research Board, the other research associations, etc., as has already been mentioned in one or two connections.

The Education Committee of the association has submitted, after some months of very careful and detailed deliberations, a series of revised syllabuses for textile courses in technical colleges, etc., and much outside support has been given to the recommendations it puts forward. These new syllabuses are the outcome of the joint discussion of existing syllabuses and standards by heads of textile departments in the universities and colleges and by the manufacturers themselves, and they have laid the foundations of a system whereby the actual needs of industry can be put plainly before those responsible for the training of the manufacturers of the future. The committee also hopes to aid the colleges in placing students in the industries both during and after their usual technical training.

It is intended not only to award prizes to inventors, research workers, and others for work of benefit to the industries or to the association, but also to establish scholarships and to subsidise research workers and educational institutions which devote themselves primarily to the objects which are before the association.

All questions relating to these matters should be addressed to the Secretary, Torridon, Headingley, Leeds.

Obituary.

PROF. ERIC DOOLITTLE.

PROF. ERIC DOOLITTLE, director of the Flower Observatory at the University of Pennsylvania, died on September 21 at the early age of fifty years. His father, C. L. Doolittle, was professor of mathematics and astronomy at Lehigh University, and the author of a well-known treatise on practical astronomy. In 1896 the father was appointed professor of astronomy at Pennsylvania University, and the son was placed in charge of the 18-in. refractor in the Flower Observatory, which was established that year in connection with the university. The latter remained there for the rest of his life, at first in the capacity of observer and instructor, and later as professor. The refractor had been specially designed for work on double stars, and the young astronomer adopted this line of study with great energy and enthusiasm. His published work embraces some 4600 pairs, and further observations are ready for issue. In 1913 Prof. S. W. Burnham, finding himself unable to continue the work of observing double stars and discussing their orbits, paid Prof. E. Doolittle the compliment of handing over his books and manuscripts to him. The latter proved himself worthy of the trust, continuing the classification and discussion of the observations of an immense number of pairs. This work is already available in card-catalogue form, and will be published later.

Another subject in which Prof. E. Doolittle took a great interest was the computation of the secular perturbations of the planets, in which he followed a method developed by Dr. G. W. Hill. His results were published by the American Philosophical Society in 1912.

In 1917 he was called on to organise and conduct a Navigational School at Philadelphia. The work, in addition to his university duties, proved beyond his strength, and brought about the breakdown which led to his early death, cutting short a career of great usefulness and promise. We are indebted for the details given above to an article in *Science* for October 22.

NATURALISTS interested in the marine and freshwater fisheries will regret to hear of the sudden death of SIR CHARLES E. FRYER at the age of seventy. Sir Charles Fryer was born in 1850, and entered the Civil Service, at the age of twenty, as Clerk to the Inspectors of Fisheries. In 1870 he became associated with Frank Buckland and Sir Spencer Walpole, and acted as secretary during the well-known inquiry into the natural history of the marine fisheries held during that and succeeding years. He had a unique knowledge of the history of the fishing industry and of the many inquiries that have been held with regard to its administration, and, though in no sense a man of science, he was keenly interested in all fishery biological questions—particularly with regard to the river fisheries. Sir Charles was due to retire at the beginning of the war, but continued to act at the Board of Agriculture and Fisheries during 1915 and 1916. Many fishery naturalists will regret his death.

THE death, on August 20, at Mussoorie, India, of MR. FRANK MILBURN HOWLETT, at the early age of forty-three, is greatly to be regretted. Mr. Howlett represented a type of entomologist comparatively rare in this country, being particularly interested in the physiological aspects of his subject. Educated at Wymondham Grammar School and at Christ's College, Cambridge, he went out to India in 1905, and in 1907 joined the staff of the Pusa Research Institute, where he afterwards became pathological entomologist to the Government of India. Although his published papers are relatively few, they exhibit marked originality of ideas. His studies of the chemotropic responses of various Diptera attracted very wide attention, and subsequent research has demonstrated that they were the forerunners of a line of investigation which has a promising future. Mr. Howlett was also a capable athlete and a clever artist, but his activities suffered severely from ill-health during his Indian service.

THE brief announcement of the death of DANIEL PAULINE OEHLERT made to the Paris Academy of Sciences on October 11 will arouse in many British geologists a host of delightful memories, for he guided an excursion of the Geologists' Association through the beautiful country of Mayenne, as well as an excursion of the International Geological Congress. Than Oehlert and his accomplished wife, who shared his labours, no better guides could be found, for they had surveyed the district for the Carte détaillée Géologique de France. Together also they published some sound palæontological papers, chiefly on Devonian fossils. Since the death of Mme. Oehlert some years ago, Oehlert had withdrawn from active geological work, and devoted himself to the museum of his native city, Laval. He was a fine man in body and in spirit.

THE death, on November 7, is reported, in his seventieth year, of DR. SAMUEL JAMES MELTZER, head of the department of physiology and pharmacology in the Rockefeller Institute of Medical Research. Dr. Meltzer is best known for his discovery, in 1912, of an improved method of artificial respiration by which he was able to resuscitate persons whose hearts had stopped beating. Three years later he announced a successful treatment for tetanus, which consisted in the injection of a prophylactic dose of serum into the wounded patient, combined with the injection of a solution of Epsom salts into the spinal membrane, which produced complete relaxation of the muscles long enough for the serum to take effect. Dr. Meltzer was a native of Russia, was educated at Königsberg and Berlin, and went to America in 1883. At the time of his death he was president of the American Association for Thoracic Surgery and of the Medical Brotherhood.

Science of November 5 announces that PROF. ARTHUR SEARLE, Phillips professor emeritus of astronomy at Harvard University, died at his home in Cambridge, Massachusetts, on October 23. Prof. Searle, who was born in England in 1837, and graduated from Harvard in 1856, became assistant in the Harvard College Observatory in 1869. He was appointed assistant professor of astronomy in 1883, and full professor in 1887, retiring in 1912 with the rank of professor emeritus. He contributed largely to scientific magazines, and in 1874 published a text-book of astronomy.

THE death is announced of DR. H. N. MORSE, professor of chemistry and director of the chemical laboratory at the Johns Hopkins University. Dr. Morse was born in 1848, and became associate at the Johns Hopkins University in 1876. He was the author of a number of scientific papers, among which may be mentioned communications on the atomic weights of cadmium and zinc, the preparation of osmotic membranes by electrolysis, and cells for the measurements of high osmotic pressures.

THE death of MR. CHARLES MCNEIL is recorded in *Engineering* for November 26. Mr. McNeil was born in Glasgow in 1847, and was the founder of the Kinning Park Hydraulic Forge, Glasgow. He was the inventor of the well-known manhole door which bears his name, and was elected a member of the Iron and Steel Institute in 1891.

Notes.

A PLEASANT surprise was experienced by those who attended the meeting of the Wireless Section of the Institution of Electrical Engineers on November 24 in meeting Dr. Alexander Graham Bell, the veteran inventor of the telephone, who had been on a visit to England and to his old home in Scotland, but is now on the way to his adopted home in the United States. Dr. Bell, who stated that his connection with telephone matters had ceased some thirty years ago, expressed his pleasure at meeting that section of the electrical world which represented the future perhaps more than any other, and referred to the remarkable developments that were being made in wireless telephony, in which the telephone had gone far beyond his most sanguine conceptions of its possibilities. The *Times* reports an interesting account given at a later interview by Dr. Bell of his researches which led up to the invention of the telephone forty-five years ago. Dr. Bell had long been interested in the mechanism of speech, and in reading of the researches of Helmholtz on the nature of vowel sounds, in a language with which he was unfamiliar, he had at first wrongly concluded that Helmholtz had transmitted such sounds by electrical means. Although he soon discovered his mistake, the idea that a transmission of this kind should be possible remained in his mind, and came to fruition later when he combined two separate lines of research which he had been prosecuting on multiple telegraphy by currents of different frequencies and on recording sound-waves for the benefit of the deaf, and thus arrived at the production and application of an undulating current representing the sound-waves of speech. The freedom of his native city of Edinburgh was conferred upon Dr. Bell on Tuesday, November 30.

PROF. W. H. ECCLES, chairman of the Wireless Section of the Institution of Electrical Engineers, in his inaugural address at the meeting referred to above, gave a masterly review of the progress of research during and since the war on the thermionic-valve tube, which originated out of the Fleming oscillation valve, and had become, in its three-electrode or "triode" form, the basis of all modern wireless telegraphy. He reviewed some of the interesting papers which had already described the intensive development of the subject under the stimulus of war, but not the least interesting part of his address was his account of some of his own extensive researches in the investigation of the interdependence of the currents and voltages in the various circuits connected to the grid, anode, and filament of the tube, with a view to greater certainty in the design of such tubes to fill the conditions required with a maximum of efficiency. Owing to the number of variables involved, he had extended his treatment from the ordinary plotting of curves in two dimensions to the manufacture of a series of clay models of surfaces in three dimensions, which should be of very great value in elucidating the properties of these tubes. Other scientific questions raised by phenomena met with in wireless telegraphy which Prof. Eccles dealt with included the diurnal variations in the ionisation of the upper layers of the atmosphere, which he suggested might possibly account for certain remarkable discrepancies in the results of wireless direction-finding apparatus at particular times in the day by causing a rotation of the plane of polarisation of the received waves.

AT the opening meeting of the Röntgen Society, held on November 18 at University College, it was announced that the first award of the Mackenzie Davidson medal had been made to Dr. F. W. Aston. The award, which was instituted to perpetuate the memory of the late Sir J. Mackenzie Davidson, is made by the council of the society for the most noteworthy contribution to its meetings during the session on some subject bearing upon radiology. Dr. Aston's paper was read on June 1, and appears in the current issue of the Journal of the society under the title "Positive Rays." It deals with the remarkable series of isotopes among non-radio-active substances, which Dr. Aston has been investigating for several years.

THE twenty-sixth annual congress of the Royal Institute of Public Health, which will be of an international character, will be held next year in Geneva, on the invitation of the University, from Tuesday, May 10, to Monday, May 16, inclusive. Further particulars can be obtained from the Secretary, 37 Russell Square, W.C.1.

THE British Silk Research Association has been approved by the Department of Scientific and Industrial Research as complying with the conditions laid down in the Government scheme for the encouragement of industrial research. The secretary of this association is Mr. A. B. Ball, Silk Association of Great Britain and Ireland, Inc., Kingsway House, Kingsway, W.C.2.

THE Government of the Czecho-Slovak Republic has established, under the Ministry of Education, a Weather Bureau in Prague, to do for that country the work formerly done at the meteorological central stations of Vienna and Budapest. The new bureau will extend the meteorological service formerly conducted in connection with the K. k. Sternwarte, Prag-Klementinum (Astronomical Observatory). The director, Dr. Rudolf Schneider, is anxious to receive for the library of the bureau all the reports of observations and meteorological publications formerly sent to the Sternwarte, and he will be glad to send to other meteorological stations and offices publications of his bureau in exchange.

FOR some time past the National Union of Scientific Workers, the Institute of Chemistry, and the British Association of Chemists have had under consideration the matter of income-tax assessment of scientific workers. After several discussions it was agreed unanimously to prepare a memorial to the Lords of the Treasury setting out under six distinct headings a claim for abatements. The memorial was forwarded to scientific societies and to research and technical staffs of various institutions and science faculties of the universities of the United Kingdom, many of which associated themselves with the memorial. It was then sent to the proper authorities. The secretary of the joint committee has now been informed that the Chancellor of the Exchequer has arranged for the Commissioners of Inland Revenue to meet a deputation of scientific workers on Friday, December 10, to afford them the opportunity of supporting their claims.

THAT excellent institution the Children's Museum of Brooklyn has sent us an issue of its *News*, which is devoted to an account of the museum's efforts to Americanise the children drawn to New York from all the countries of Europe. The museum, it is claimed, can supply that which the teacher cannot provide, namely, an American background for the intellectual life of the child. This is effected by helping the pupils to visualise incidents in the lives of past Americans through the numerous models and objects of historic interest in the museum. By contact with these concrete exhibits the abstract knowledge provided in school becomes more real to them, and a personal link with the country's past is forged in the mind of each child. The influence of the museum is even wider than mere Americanisation, for "the person whose intellect is overtrained to the neglect of the senses is perhaps a greater menace to the community than the illiterate."

THE fourth annual Report of the National Research Council of the United States of America consists of 68 pages, and shows that a large proportion of the programme of the Council is now in operation. The funds are provided mainly by the Carnegie Corporation of New York, the Rockefeller Foundation, the General Education Board, and the Commonwealth Fund. Its purpose is to promote research in the mathematical, physical, and biological sciences with the object of increasing knowledge and contributing to the public welfare. One of its thirteen divisions deals with foreign relations, and represents the Council at the meetings of the International Research Council. Another deals with the physical sciences, and already has research committees on atomic structure, celestial mechanics, X-ray spectra, electrodynamics, photo-electricity, etc. The engineering division has committees on fatigue in metals, heat treatment of steel, pyrometers, highways, etc. The chemistry division has committees on synthetic drugs, colloids, ceramics, etc. The Council is to be congratulated on the speed with which it has got to work.

WE have received a copy of the appeal issued by the University of Birmingham for 500,000*l*. The present financial position, as set forth in the circular, is indeed critical. The increase in cost of administration and maintenance, coinciding with an increased demand on the capacity of the University—each additional student costs about three times as much as he contributes—has made bankruptcy the only alternative to a large addition to its resources. Among the objects of the appeal the first place is rightly given to the improvement of the salaries of the teaching staff, especially of the non-professorial section. Provision has also to be made for the enlargement of existing departments to cope with the demands made upon them. It is further pointed out that additional chairs are required in many subjects (*e.g.* mathematics, physics, chemistry, engineering, and biology) and that increased facilities for research are urgently needed. There is, moreover, an insistent and growing demand on the part of industrial workers for extra-mural work, and classes have been created for trade unionists, in which special instruction is given in English literature, economics, and modern history, in co-operation with the Workers' Educational Association. The provision of hostels for men students is also very desirable. Finally, it is urged that grants or gifts to the University will in all probability secure an equivalent from the Government. A first list of contributions shows promises amounting to more than 250,000*l*., of which nearly one-half is given by representatives of the petroleum mining industry for a petroleum mining endowment fund. We sincerely hope that further lists may show that the Birmingham and Midland district is alive to its responsibilities in the matter and that the desired sum may be raised.

IN the Museum Journal of the University of Pennsylvania (vol. xi., No. 1, March, 1920) a valuable article, with excellent illustrations, is published describing a collection of "fetish" figures from equatorial Africa. The word "fetish" is now suspect among anthropologists, as its meaning has been unreasonably extended. At the same time, the great majority of these wood carvings have undoubtedly some connection with the religious magic of the negro, and among the special group of the Bakuba-Baluba peoples in the South-Western Congo region the best and least contaminated negro art is found among a race which possesses a more highly developed system of cults, religions, or magico-religions than any other Congo people possessing such a high degree of culture.

THE *Archives of Radiology and Electrotherapy* for October (No. 243) contains the continuation of a sketch of the history of electrotherapy by Mr. H. A. Colwell. The period dealt with is from 1800 to 1879, and the apparatus of various inventors is described and figured, such as Golding-Bird's contact-breaker (1838), Neef and Wagner's and Benedict's induction coils, Piscii's magneto-electric shocking machine (1832), and various portable batteries. Contact-breakers worked by an assistant were in use as late as 1849. The account, which is a very interesting one, is to be continued.

Medical Science: Abstracts and Reviews for November (vol. iii., No. 2) contains a critical review of the cancer problem, particularly of work done during the last twenty years. In England and Wales one woman in eight and one man in eleven above the age of thirty-five years dies of cancer. Acquired immunity to transplanted cancer in the mouse and rat can be produced by means of *living* cancer-cells. Altmann's granules are absent from the cells of malignant growths. The blood and tissues of cancerous persons contain more potassium than normal, and human cancerous material contains more radium than normal. Considerable space is devoted to the various methods of treatment of cancer, which it is concluded must proceed along the lines of a judicious combination of surgery and irradiation.

In the Museum Journal of the University of Pennsylvania (vol. x., No. 4, December, 1919) we have an account of head-hunting among the Jivaro tribe, occupying a large territory on the eastern slope of the Andes in the Republic of Ecuador. They have been called cannibals, but they never eat any part of the human body. The mummified heads of their enemies are the most esteemed war trophy, because the head must be present at the victory feast which the hero is expected to give. The head must be preserved, because it requires many months to clear a field and grow yucca and bananas to provide food for the numbers attending the feast. The head is fixed on a staff and paraded, with a tribute to the valour of the slayer, before the assembled tribesmen. After this an orgy of eating and drinking continues for days until all the supplies are exhausted.

The way in which one part of an organism regulates the activity of another is a problem of supreme interest in biology. In unicellular organisms the transmission is local, but in multicellular organisms conduction may be by the circulating fluid or by nerves. Conduction by nerves is the main theme discussed by Prof. R. S. Lillie in an address on "The Nature of Protoplasmic and Nervous Transmission" (*Journ. Physical Chemistry*, vol. xxiv., 1920, p. 165). The propagated disturbance in nerves cannot be a chemical transport because of its rapidity. A nerve-impulse is always accompanied by an electrical change of potential of sufficient voltage to stimulate another nerve. The hypothesis is advanced that the current of action stimulates a contiguous portion of nerve, thus accounting for the transmission of the impulse. The negative electrical potential at an active part of the nerve is short-circuited through the surrounding electrolyte solution, so that the current passes in at the active portion of the nerve and out at an inactive part. The inactive portion of nerve is thus stimulated as if by the cathode of an external stimulating circuit. The time required for the potential to reach its maximum is 0·001 of a second, and, assuming that the current is effective over a length of 3 cm., the rate of conduction would be 30 metres per second; this is the value obtained for a frog's nerve at temperatures of about 15° C. The propagation of the nerve-impulse is compared to "passive" iron and its activation, the two processes having much in common.

The newly established French Office Scientifique et Technique des Pêches maritimes is issuing a series of Notes et Mémoires, and No. 2, "Le Merlu," by Dr. Ed. le Danois, has just been published. It is a summary of our knowledge of the life-history of the hake. Of late years this has become one of the most important of marine food-fishes because of its wide distribution. Compared with our knowledge of other fishes, very little is known as yet of the general biology of the hake, and it has been proposed (by the International Council for the Exploration of the Sea) to institute investigations (to be carried out by France, England, and Ireland) on this and other fishes inhabiting the south-western European area. The paper under notice is therefore opportune. It is almost entirely a *résumé* of the research which has been carried out on the hake by the various fishery authorities, and it is accompanied by a series of sketch-charts representing the seasonal distribution of the fish, the localities of fishing, the spawning places and periods, and the migrations. A summary of the European commercial hake fisheries is also given. The author discusses the causes of migration, and suggests a factor which seems to be new (though this is difficult to say, for no references to published work are given). Food is not a factor, for that taken by the hake is variable, and during its spawning periods (when its migrations are most noticeable) it does not eat at all. Its migrations cannot be correlated with any seasonal changes in the plankton. On the other hand, changes of temperature throughout the year either enlarge or restrict its range of distribution, and variations of salinity are also factors. The body of the young hake is relatively dense, but as the genital organs mature the density diminishes. This leads to a greater energy requirement in relation to the locomotion of the fish, and it seeks water of lower salinity or higher temperature, or both. Thus, by reason of "the principle of least effort," the hake migrates into shallower, warmer, and less saline waters as its breeding season approaches.

A Chadwick public lecture was delivered by Prof. J. B. Farmer in the lecture hall of the Medical Society of London on November 5, the subject being "Some Biological Aspects of Disease." The lecturer pointed out that it was now a recognised fact that co-ordinated growth in an organism leading to the development of a particular form depended on the serial or sequential nature of the reactions which went on in its cells and tissues. Recognition of this was essential to a proper appreciation of the larger problems of health and disease. By the consideration of examples, taken chiefly from the plant-world, it was shown how differences in chemical or physical environments produced definite changes in the organism, though close analysis of the facts emphasised the essential point that it is only when environment was able to interfere, as it were, with the protoplasm itself that response of this kind was obtained. The effects of the temporary isolation of parts of the body from the material influences exerted by adjacent parts might result in a permanent loosening of the ties which previously had knit the constituent cells into a coherent organism, while the union of parts hitherto separate sometimes led to the formation of a synthetic new organism; lichens are striking examples of this. The consequences of the mutual relations established between parasite and host were dealt with, particularly with reference to the abnormal growths which can be traced to substances injected by parasitic animals. Prof. Farmer then passed on to discuss briefly the abnormal growths or neoplasms which originate as the result of obscure changes taking place within the cells themselves. The essential features of malignant growths were described and the outline of a plan of research for the advancement of our knowledge of the causes of cancer was suggested.

THE proceedings of the sixth annual Indian Science Congress, which was held in Bombay on January 13–18, 1919, have been published in the Journal and Proceedings of the Asiatic Society of Bengal, vol. xv., No. 4. The volume contains full reports of the presidential address delivered by Sir Leonard Rogers, an abridged version of which appeared in NATURE of May 29, 1919, and of the presidential addresses delivered to the various sections. The latter are followed by brief abstracts of the other papers read at the meeting.

A GAZETTEER of streams of Texas has been compiled by the United States Geological Survey and published as Water Supply Paper No. 448. Source, length, and topographical details are given in all cases, while in that of the more important streams other information, such as season of greatest flow, gradient, and precipitation in the basin, is added. The work is based on the best maps available, supplemented by personal reconnaissance. References are given to sheets of the topographic survey. The addition of a map to the volume would have rendered it more useful for reference.

WE learn from the *Geographical Journal* for November that Col. P. H. Fawcett is planning to return to his work of exploration in Western Brazil east of the Bolivian frontier. The expedition, which has the active support of the Brazilian Government, will include, besides Col. Fawcett, two Brazilian officers and Major Lewis Brown, of the Australian infantry. The investigation of the Indian tribes is one of the chief objects of the expedition. Cartographical work will be governed by astronomical observations and based for its longitudes upon the courses of the main rivers as determined by the work of the Rondon Commission.

THE potentiality of Australia for white settlers is discussed by Dr. Griffith Taylor in an article entitled "Nature *versus* the Australian" in *Science and Industry* for August. After a discussion of the amount and variability of rainfall in Australia, Dr. Taylor divides the country into seven regions based on rainfall, in terms of which agricultural and pastoral production can be classified. Farming and close white settlement generally are, and, he contends, will be, confined to three of these regions, which embrace the Riverina, Victoria, Tasmania, eastern Queensland, the north-east of New South Wales, and "Swanland" in Western Australia. The distribution of minerals, especially coal, will in time result in dense population irrespective of agricultural potentiality, but in Australia the coalfields occur in the regions favoured by climate, and so tend to more centralisation of population. Dr. Taylor is not hopeful of white settlement in tropical Australia, and gives adequate climatic reasons for his opinions. The paper concludes with a tentative map showing the habitability of the globe. In the southern hemisphere south-eastern Australia and New Zealand alone are indicated as areas with a potentiality in white settlement of more than 125 per square mile.

THE Department of Agriculture of the Union of South Africa has recently issued a report (Bulletin No. 4, 1920) on investigations in the wool industries of Great Britain and the United States of America with a view to the betterment of the industry in South Africa. An interesting survey is made of the kinds and qualities of wool and its substitutes, and a useful comparative statement gives the countries to which South African wool was exported from 1913 to 1919. Next to Great Britain, Germany was the largest purchaser of South African wool previous to the war, and since then her place has been taken by America and Japan. Very informative tables are appended showing the world's wool production and the estimated world's wool stocks in the 1919–20 season. While the usual annual supply of the world is estimated at 2,700,000,000 lb., there was available in 1919–20 for consumption by manufacturing countries as much as 4,200,000,000 lb. The defects of South African wool are gone into in detail, and useful suggestions are made with a view to their elimination. Great care appears to have been taken in estimating the capital expenditure required to build and equip factories for specialisation in the various branches of manufacture of woollens and worsteds, the expected output from certain machines is properly tabulated, and the cost of labour is shown for England, France, the United States, Germany, and Austria, while the cost of running and maintenance of plant is dealt with systematically.

UNTIL recently the process of the melting and casting of metal in a brass mill was very similar to that practised 240 years ago. As a rule, small crucibles having a maximum holding capacity of about 300 lb. were used. The advent of the electric furnace, however, is now rapidly revolutionising the industry. In one type the heat of the electric arc is used, and in the other—the induction type—the metal is melted by the electric currents induced in it. An interesting account of the latter kind of furnace is given by Mr. G. H. Clamer in the Journal of the Franklin Institute for October. Official tests show that about 10 lb. of two-to-one yellow brass are brought to the casting temperature (2000° F.) per electric unit expended in the Ajax-Wyatt furnace. The metal is melted directly by the Joule effect, the electromagnetic forces keeping it circulating. A very interesting induction furnace has been invented by Dr. Northrup. Instead of using alternating current of the ordinary commercial frequencies, he uses currents having frequencies of 10,000, similar to those sometimes used in long-distance radio-telegraphy. In this case no resistance column of molten metal is necessary. The metal contained in a plain cylindrical crucible is brought to any required temperature by the induced eddy currents. These furnaces are suitable for very high temperature melting, such as is required, for instance, by alloy steels and precious metals.

UNDER the comprehensive title of "Sterilisation of Water by Chlorine Gas" a paper by Capt. J. Stanley Arthur was read before the Institution of Mechanical Engineers on November 19. The part of the paper dealing with the general aspect of the subject adds little or nothing to our knowledge, and contains statements which, to say the least, are still debatable. For example, the author states that water treated with chlorine gas is less liable to an objectionable taste than when treated with bleaching-powder, and, further, that any taste so imparted can readily be removed by the addition of sulphur dioxide. Other experimenters have found that there is little or no difference between bleaching-powder and chlorine gas as regards taste, and also that some tastes produced by chlorination are absolutely unaffected by the further addition of sulphur dioxide. Also, no mention is made of the pioneer work on chlorination of Houston and McGowan at Lincoln in 1905 or of any of Houston's later work on the subject. The greater part of the paper consists of the detailed description of an American device for accurately administering the dose of chlorine and its adaptation for the purpose of sterilising the water-supply to the troops during the war. These descriptions are very clearly stated and well illustrated with careful drawings. No other types of chlorinators are described, although there are others equally efficient now on the market. The paper concludes with a warm tribute to Sir William Horrocks for his work on water purification for the Army, and is further evidence of the great part played by the sanitary section of the R.A.M.C. in winning the war; it is probable, however, that Sir William and his colleagues would be the first to acknowledge their indebtedness to others not mentioned in Capt. Arthur's paper.

THE latest catalogue (No. 407) of second-hand books offered for sale by Mr. F. Edwards, 83 High Street, Marylebone, W.1, is devoted to botany, ranging over the subjects of agriculture, gardens, orchids, trees, fruits, fungi, lilies, and roses. It should be of interest to many readers of NATURE. Many choice and rare works are listed, among them several herbals, a complete set of the *Annals of Botany, Curtis' Botanical Magazine*, 1787–1915, and Sir J. D. Hooker's "Botany of the Antarctic," 6 vols.

WE are informed that the office of the Assistant Commissioner of Forestry for England and Wales (Mr. Hugh Murray) is now situated at 30 Belgrave Square, London, S.W.1. The headquarters of the Commission remains at 22 Grosvenor Gardens, London, S.W.1.

Our Astronomical Column.

THE LEONID METEORIC SHOWER.—Mr. Denning writes that on November 15 and 16 the Leonids returned in moderate numbers. Mr. C. P. Adamson, observing at Wimborne, Dorset, watched the sky during a period of ten hours, and saw thirty-three Leonids out of a total of ninety-eight meteors recorded. The radiant point was placed at $150°+22°$, and the display furnished objects of the usual swift and streak-leaving character.

Miss A. Grace Cook, at Stowmarket, also witnessed the return of the meteors on the same nights and determined the radiant in precisely the same position as Mr. Adamson. Mr. A. King made observations from Lincolnshire, and on November 15, during a watch of three hours between 11h. 18m. and 14h. 37m., saw thirty meteors, of which nine were Leonids directed from a radiant at $152°+23°$. Other showers were seen from $63°+22°$ (five meteors), $107°+35°$ (seven meteors), and $116°+49°$ (five meteors) at the middle of November.

The reappearance of the Leonids adds another link to the chain of past observations, which prove that this stream of meteors is visibly continuous throughout the entire orbit, and that it may be viewed every mid-November when the prevailing atmospheric conditions are favourable.

RADIATION PRESSURE ON ELECTRONS AND ATOMS.—Mr. Leigh Page discusses this subject in *Astrophys. Journ.* for September. It was formerly concluded that radiation pressure reached a maximum for particles of diameters comparable with a wave-length, and fell off rapidly for smaller particles. The present paper shows that this result neglects resonance, and that the radiation pressure on an atom "depends on the intensity of that portion of the incident radiation which has a frequency equal to the natural frequency of the oscillator." It is deduced that the pressure of solar radiation is greatest on an atom which has a resonant frequency in the infra-red near to wave-length 9000 Å., being within one-third of this maximum value for the range 4000 Å. to 28,000 Å. The pressure may be further increased if the atom has more than one resonant frequency.

It is shown that in certain circumstances the repulsive force may be thirty times that due to gravitation. It thus seems sufficient to explain most of the phenomena of comets' tails, and removes the difficulty formerly felt, namely, that the spectroscope shows the presence of certain gases in the tail, for the molecules of which the pressure was thought to be negligible. The author states that since writing the paper he has found that some of his conclusions were published by M. Gouy in 1913 (*Comptes rendus*, vol. clvii., p. 186).

PERTURBATIONS IN A STELLAR ORBIT.—There are not many cases where perturbations in stellar orbits can be observed with any degree of accuracy. Mr. J. S. Paraskevopoulos examines the case of 13 Ceti in *Astrophys. Journ.* for September. This is a visual binary with a period of 6·88 years, while the brighter star is a spectroscopic binary with a period of 2·0818 days. The eccentricity of the orbit of the visual pair is 0·725. The author has remeasured a number of spectrograms taken at the Yerkes Observatory between 1906 and 1913, deducing separate orbits at three different epochs. These show that the period is shorter by 1/200 day at apastron of the visual companion than at periastron, this being analogous to the period of the moon at aphelion and perihelion. Motion of the line of apsides is well established. It is concluded that the mass of the visual companion does not fall far short of, and may exceed, that of the spectroscopic pair. Taking the parallax as 0·050″ (J. A. Miller), m/M becomes 1·32.

The system 85 Pegasi is referred to, in which Prof. G. Van Biesbroeck deduced that the mass of the brighter component was only 0·36 of that of the whole system.

Anniversary Meeting of the Royal Society.

AT the anniversary meeting of the Royal Society, held on Tuesday, November 30, the report of the council was presented, and the president, Sir Joseph Thomson, delivered his valedictory address. Sir Joseph succeeded Sir William Crookes in the presidential chair in 1915, and has therefore served through as difficult a period as any in the history of the society. What the society and the nation owe to his activity and genius can be understood only by those who have been associated with him on some of the many committees or other bodies constituted during these troublous years to maintain national life and security. All the resources of British science have been organised and rendered available for public service with these ends in view; and a record of the aid thus afforded to the country by the society during Sir Joseph Thomson's presidency would afford convincing evidence of the value of science to the nation and of the patriotic spirit of scientific workers. Sir Joseph is succeeded as president by Prof. C. S. Sherrington, Waynflete professor of physiology in the University of Oxford, a short account of whose notable work on the central nervous system appears elsewhere in this issue.

State Aid to Science.

Several important matters are referred to in the report of the council of the society. In March of last year a memorandum on State aid to science through grants to universities and to the Royal Society was submitted to the Lords Commissioners of H.M. Treasury. The memorandum contained the following statement of the relation of purely scientific work to human progress:

"The promotion of research in pure science without regard to its industrial applications is important:

"(1) Because science is not merely the handmaid of arts, but depends on study which elevates a nation, and wherein the natural curiosity of the mind finds exercise and satisfaction.

"(2) Because the history of science shows that many of the discoveries which have revolutionised old industries, and established new ones, have been made by those whose aim was simply to extend our knowledge without any reference to practical applications.

"The encouragement by the nation of research of this kind must, in our opinion, follow different lines from those which may be adopted with advantage for promoting research in applied science. Any direct endowment of research, to safeguard it from abuse, involves something in the nature of a report at regular intervals which should be submitted to experts for their approval. Research in pure science is inevitably intermittent, and may be gravely injured if required to show results at any particular date. Its ideas are often novel, and so far opposed to existing views that they may not obtain the approval of men with long-established reputations, such as those to whom the reports would naturally be submitted.

"A large part of this pioneer work in science has in the past been done in the universities, and this is likely to be true to a still greater extent in the future. We consider, therefore, that the best way of promoting research in pure science would be to put the universities in such a position that they can provide for their teachers adequate salaries, appliances, and time for research. This will involve increased grants to the universities. These will be necessary even if the universities are merely to maintain their output of research at the present level, owing to the greatly increased expense of the upkeep of a laboratory due to the higher wages and cost of material. But in our opinion research in our universities ought to be greatly extended and not merely prevented from decreasing. A substantial increase in the grants to universities and university colleges is therefore required.

"For these reasons we are agreed that for the advancement of science the first need is to make adequate provision for the promotion of science at the universities."

The purpose to which the Government grant to the Royal Society is applied includes: (1) Grants for providing apparatus and materials for researches approved by the Government Grant Committee. (2) Grants in aid of scientific expeditions, such as those for observing eclipses or for the exploration of the polar regions. Grants have also been made separately by the Treasury to international undertakings, such as those to the International Geodetic Association (300*l.*), the Seismological Association (160*l.*), and the Metric Convention (200*l.*-300*l.*), which in future will be organised by an International Research Council formed under the authority of the principal academies of the countries concerned.

In response to the council's memorandum the Lords Commissioners increased the annual grant for research from 4000*l.* to 6000*l.*, and, although they were not prepared to make a separate annual grant for scientific expeditions and stations, a non-recurrent grant of 5000*l.* was included in the Parliamentary estimate for the year. With regard to international research, they proposed the provision of an annual grant of 2000*l.*, provided the society would "assume responsibility for the payment of subscriptions for all classes of international research." After correspondence this responsibility was somewhat qualified, and the provision proposed accepted.

Rudolf Messel Bequest.

By the terms of the will of the late Dr. Rudolf Messel the Royal Society becomes entitled to four-fifths of the residuary estate. It is estimated that the value of the bequest will be, in the first instance, not less than 70,000*l.*, ultimately increasing to about 90,000*l.* The clause of the will governing the disposal of the residuary estate is as follows:—"I give four of such parts to the Royal Society, Burlington House, and the remaining part to the Society of Chemical Industry, Broadway Chambers, Westminster, and, without imposing any trust or obligation, I think fit to set forth my desires with regard to the fund given to each of these societies as follows: (i) The fund should be kept separate from the other funds of the society and be known under my name or otherwise as the society may think fit. (ii) The capital of the fund should be kept intact. (iii) The society should apply the whole of the income of the fund in such manner as it may think most conducive to the furtherance of scientific research and such other scientific objects as the council of the society may determine, and should not apply any part of the income for such charitable objects as the granting of pensions and the like . . ."

It must not be supposed, however, that the society is relieved of financial anxiety by this generous bequest or by the State grants referred to above. The bequest has to be kept separate from the general funds, and the society acts solely as administrator of the Government grants. On account of increased expenses, a heavy deficit on the year's working had to be faced; and the council points out that even if the whole income from the Messel bequest were used to defray the cost of publications, there would still be a deficit. The annual subscription of fellows has been raised and steps have been taken to reduce expenditure wherever possible, yet the situation is still serious, and further financial provision must be secured if the society is to maintain its activities.

Presidential Address.

In his presidential address Sir Joseph Thomson referred to distinguished achievements of fellows of the society lost by death during the year, and to the admission of the Prince of Wales as fellow on January 22 last. He directed attention to the large increase in the cost of publishing the Proceedings and Transactions, and suggested that something might be done to make the papers published by a society as accessible to the scientific public as those published in other ways. "I think," he added, "some improvement in our sales might possibly be effected and science benefited if there were some organisation, private or otherwise, for the sale of separate papers. The formation of a library, to include all papers on one of the great branches of science, such as physics, requires a longer purse and more bookshelves than most are able to afford. But there are many, I think, who would like, and could afford, to form a fairly complete collection of the literature of one or more of the subdivisions of the subject in which they are especially interested—say, for example, electrical waves or low-temperature research. As lists of the papers in these subdivisions are published at regular intervals by various agencies, it ought not to be difficult to arrange for the distribution of the separate papers if these could be obtained from the societies."

The Medallists.

The Copley medal is awarded to DR. HORACE T. BROWN in recognition of his work on the chemistry of carbohydrates, on the assimilation of atmospheric carbon dioxide by leaves, and on gaseous diffusion through small apertures. As was the case with Pasteur, so with Horace Brown, problems and difficulties arising out of a branch of the fermentation industry supplied the incentive to investigations which are of fundamental importance in chemistry and botany. His work began in 1871 with the investigation of one of the diseases of beer, and includes an exhaustive study of the chemistry of starch, the germination of the barley grain, and the changes occurring in the green leaf during photosynthesis.

The Rumford medal is awarded to LORD RAYLEIGH, who is distinguished for his researches into the properties of gases at high vacua, and whose work has opened the way to many valuable investigations. Some years ago Lord Rayleigh made a number of interesting observations on the afterglow in various gases noticeable after the cessation of an electric discharge, and these led in 1911 to his Bakerian lecture on "The Afterglow of Nitrogen." The investigation thus started has proved the subject of much of his recent work, and in a series of most valuable papers he has studied the properties of the gas in which this afterglow is visible.

A Royal medal is awarded to PROF. GODFREY HAROLD HARDY, who is well known both in this country and on the Continent for his researches in pure mathematics, particularly in the analytic theory of numbers and allied subjects. Immediately after taking his degree at Cambridge Prof. Hardy engaged in a series of researches on the theory of functions of a real variable, from which results of the greatest importance and generality were obtained, at first by himself alone and later in collaboration with Mr. J. E. Littlewood. Among the more important researches of which Prof. Hardy is sole author may be mentioned papers on Dirichlet's divisor problem, on the representation of numbers as the sum of n squares, on the roots of the Riemann ζ-function, and on non-differentiable functions.

A Royal medal is awarded to DR. WILLIAM BATESON, who is universally recognised as a leading authority on genetics, and has done more than anyone else to put that branch of inquiry on a scientific basis. The work that stands to his name is, however, but a fraction of that which he has inspired wherever biological research is prosecuted. In conjunction with Prof. Punnett he worked out in detail one of the earliest cases of sex-linked inheritance. Peculiar association of genetic factors in gametogenesis had previously been discovered by the same authors and described under the terms "coupling" and "repulsion." In 1911 they published two papers which proved that these phenomena are part of a more general phenomenon of linkage, the orderly nature of which was pointed out. Since these papers appeared the phenomenon has been shown by various workers to be widespread in both animals and plants. Three papers by Bateson and C. Pellew record a discovery of high interest and importance, viz. that the germ-cells of the same plant may vary in their genetic properties. It is further pointed out that the variation proceeds in an orderly way from the base of the plant to the apex. The conception is a novel one, and is bound to have great influence on the development of genetical theory.

The Davy medal is awarded to MR. CHARLES THOMAS HEYCOCK, who, in collaboration with the late Mr. F. H. Neville, published a remarkable series of papers, all characterised alike by great experimental skill and originality, as well as by precise, yet simple, mathematical treatment. The molecular complexity of metals when dissolved in other metals, the composition and constitution of binary and ternary alloys, and the part which the eutectics play during the cooling of a complex alloy were clearly revealed, not only by freezing-point methods, but also by a most ingenious method of chilling, as well as by etching by means of many new reagents. These researches have not only added very greatly to our theoretical knowledge and conceptions, but have also been of the greatest importance to industrial metallurgy in many directions.

The Darwin medal is awarded to PROF. ROLAND HARRY BIFFEN, who has worked out the inheritance of practically all the obvious characters of wheat and barley. Perhaps his best-known work is that on the inheritance of strength in wheat and on the inheritance of susceptibility and resistance to yellow rust in wheat. Biffen's activity is not by any means to be measured by his published work. Two of his new wheats—Little Joss, which owes its value to its immunity from rust, and Yeoman, which combines high yield with first-class baking quality—are among the most popular wheats in the country, and together account for something like a third, or even a half, of the wheat crop of England.

The Hughes medal is awarded to PROF. OWEN WILLIAMS RICHARDSON for his researches on the passage of electricity through gases, and especially for those relating to the emission of electrons from hot bodies—a subject which Prof. Richardson has made his own and christened "thermionics." The subject is of great industrial as well as of scientific importance.

The anniversary dinner of the society was held on Tuesday at the Royal Palace Hotel, Kensington.

The Mackie Ethnological Expedition to Central Africa.

THE REV. J. ROSCOE, the leader of the Mackie Ethnological Expedition to Central Africa, has recently returned to this country after an absence of more than eighteen months. The expedition, which was made possible by a generous donation from Sir Peter Mackie, placed at the disposal of the Royal Society, had for its object the investigation of the laws, customs, and beliefs of the native tribes under British rule in Central Africa, particularly in the Uganda Protectorate, in accordance with a scheme which had been planned and urgently advocated for many years by Sir James Frazer, but for which funds had hitherto been wanting. The tribes which the expedition proposed to investigate had been very little modified by contact with civilisation, and it was felt that a detailed examination of their institutions and beliefs would not only add very materially to our scientific knowledge, but would also conduce to the good government and economic development of the country in the future.

The expedition left this country in the spring of 1919. The first part of its labours was devoted to the study of the Bahima of Ankole, an important pastoral tribe, in the western part of the Uganda Protectorate. During a stay of three months Mr. Roscoe gathered an immense amount of detailed information relating to the clan and totem organisation and tabus, the system of government, and the beliefs and rituals connected with the care of cattle and the milk, which play an important part in regulating the life of the community.

From Ankole the expedition moved to Kigezi, where a short stay was made for the purpose of studying the Bakyiga, a large and fierce mountain tribe of many clans, partly pastoral, partly agricultural. The tribe is believed to be the original stock, which the Bahima were never able to conquer. This is borne out by the fact that they are of the same type as the slaves in Ankole and the lower order of people in Bunyoro.

On leaving Kigezi the expedition set out for Bunyoro, proceeding westward to the arm connecting the two lakes Edward and George, and then northward along the line of these lakes and Lake Albert—a country very little known, which was found to be of extraordinary beauty.

In the course of a short rest of a week a superficial examination of the Bamba and Bakonja of Mount Luenzori was made. The expedition then proceeded from Port Ntoroko by steamer to Butiaba, the port for Masindi, the capital of Bunyoro, where it entered upon the second and, as it proved, the most fruitful part of its labours.

The King of Bunyoro gave every assistance to the expedition. He is now a Christian, but as the repository of the tradition and practice of the religion of the people his knowledge, which was placed freely at Mr. Roscoe's disposal, proved of inestimable value.

The Bunyoro tribe, or rather nation, consists of two distinct races, the Bahuma and the Bairu—the latter a subject people of agricultural peasants belonging to Bantu stock and descended from the original inhabitants of the country; the former a purely pastoral people akin to the Gallas, who form a ruling aristocracy, descended from a people which invaded and conquered the country from the north. Intermarriage between the two races is rare, though not absolutely forbidden. The greater part of the life of the king is, or rather used to be, devoted to ceremonial observances connected with his cattle in order to increase the progeny of man and beast and the supply of food. So much was this the case that the whole of his day was mapped out for him, and he rarely, if ever, quitted his kraal. One peculiar feature of the ritual was a daily meal at which he partook of sacred beef. The royal cook knelt before the king and placed four pieces of meat in the king's mouth with a special fork, taking care not to let the fork touch the royal teeth under penalty of death.

From Masindi the expedition proceeded to Mount Elgon, where it made some further inquiries among the cannibal Bagesu, whom Mr. Roscoe had already visited and described. It had been intended originally to pass northward into Karamojo in order to investigate the Turkana, an interesting people, remarkable for their great stature, of whom very little in detail is known. Unfortunately, military operations which were being carried on in that region made that impossible. The expedition therefore turned to Busoga, and after a short stay there returned to Bunyoro, whence it started on its homeward journey down the Nile.

E. N. F.

The Indian School of Mining and Geology.

THE recent decision of the Government of India to establish a School of Mining and Geology at Dhanbaid follows the recommendations of Sir Duncan McPherson's Committee of 1913–14 on mining education, of the expert Committee which examined the system of mining education in England in 1914–15, and of the Indian Industrial Commission of 1916–18. The site of the proposed school has caused some difference of opinion in the past. Thus the Calcutta University Commission enumerated the many advantages which Calcutta was believed to possess, but in finally deciding on Dhanbaid the Government of India has followed the recommendations of the three Committees, and come to a conclusion with which those who know local conditions best will cordially agree. Dhanbaid enjoys an excellent situation, and return visits to the coal-mines will occupy only a few hours; from Calcutta they would take at least thirty-six hours.

The provision at present made for mining education in India comprises (1) courses at the Sibpur Engineering College, near Calcutta, and (2) evening classes on the coalfield. The existing provision for higher training in geology is even less satisfactory. The proposal is that the new school will be an institution of collegiate type, in which the highest form of teaching in the art of mining and its accessory sciences is to be undertaken, so that in time it will rank with similar institutions in this country, and give equal opportunities for the study of geology and mining in all their branches. Thus natives of India will eventually be able to obtain in their own country that specialised training which to-day is an essential qualification for the more responsible posts in the mining and geological professions.

With the school on the coalfield both students and staff will be in close contact with a well-developed mining industry, and the great desirability of having intimate relationship between the industry and mining education will be realised. Further, the teachers of the evening classes, who undertake part of the work of imparting elementary mining education at present, will be enabled to keep themselves *au courant* with the latest developments and to obtain advice and assistance from the school.

The Central Government will assume responsibility for its maintenance and administration, as the development of India's mineral industry is an Imperial undertaking which affects vitally the general advancement of the country as a whole. Under the Reforms Scheme only central agencies and institutions for research and for professional or technical training or for the promotion of special studies will be under the Government of India, as it is only for such that funds can be allotted from the Imperial revenues.

The fact that both coal and metalliferous mines are now being developed in other Provinces is not lost sight of. The school will be open to students from all parts of British India, and facilities are to be provided for others from the Indian States. Although the school will supply trained officials for the coal-mining industry, it has been definitely laid down that instruction in metalliferous mining shall receive due attention. It is hoped that provincial Governments, mining associations, and the great mining companies of India will give liberal support to the school by the institution of scholarships, travelling fellowships, and lectureships.

Elementary instruction in coal and metalliferous mining is not one of the objects of the school; this will receive due care from the provincial Governments concerned. A final decision has not yet been reached with regard to the higher training of mine surveyors, which is left for the future consideration of the governing body. Should a metallurgical institute be established in the future at Jamshedpur, full arrangements are to be made for the interchange of facilities in research and advanced training between it and the new School of Mines and Geology.

The school will not be affiliated to any university, at least in its initial stages, though it must, of course, maintain touch with the highest form of educational thought, methods, and standards. Both the Universities of Calcutta and Patna will be represented on the governing body. The latter consists of fourteen members, presided over by the Director of the Geological Survey of India. Other official members are the Chief Inspector of Mines, the principal of the college, and the representatives of the Governments of Bengal and of Bihar and Orissa. The rest are non-officials, appointed by the mining associations, etc., of various parts of India, and the two university members already mentioned.

Steps have already been taken to acquire a suitable site at Dhanbaid, and the governing body is to formulate proposals at once for buildings and equipment, staff, courses of study and examinations, rules of admission and an estimate of the initial and recurring costs of the school.

J. C. B.

University and Educational Intelligence.

CAMBRIDGE.—Mr. A. B. Appleton (Downing College), Mr. D. G. Reid (Trinity College), and Mr. A. Hopkinson (Emmanuel College) have been appointed demonstrators in anatomy, and Mr. A. Hutchinson (Pembroke College) has been re-appointed demonstrator in mineralogy and assistant curator of the museum of mineralogy. It is proposed that Dr. Myers should be appointed reader in experimental psychology, and that the University lectureship which he now holds should cease.

A LECTURE on "Recent Developments in Astronomy," in connection with the London County Council's lectures for teachers, will be given by Prof. A. Fowler at the Regent Street Polytechnic, W.1, on Saturday morning, December 4, at 10.30 o'clock. The chair will be taken by Mr. E. Walter Maunder.

THE Toronto correspondent of the *Times* stated on November 25 that, including the grant of 1,000,000 dollars from the Government of the Province of Quebec and 1,000,000 dollars from the Rockefeller Foundation, the McGill University centennial endowment fund has reached the total of 6,321,000 dollars (approximately 1,580,000*l.*), which exceeds the amount the recent campaign was started to raise.

AN exchange of university students between Belgium and the United States has recently been made; twenty-four Belgian students have been admitted to American universities and twenty-two Americans have entered Belgian universities. The exchange has been arranged and endowed by the Education Foundation of the Belgian Relief Commission from funds which remained after the Commission had completed its work in 1919. All travelling expenses of the selected students will be met from this fund, and fees will be remitted by the Belgian and some of the American universities for exchange students. In addition, Belgians entering American universities will each receive a maintenance grant of 1000 dollars per annum, while American students in Belgian universities will each be allowed a sum of 10,000 francs per annum for living expenses.

IN his presidential address to the members of the British Academy, now reprinted, Sir F. E. Kenyon discussed the subject of international scholarship. Like other societies, the Academy suffers from lack of funds, and the appeal now made for a Treasury grant will meet with the support of all who are interested in learning. The question of the resumption of relations with German scholars was considered, and while Sir F. Kenyon sees the difficulties which impede any *rapprochement*, he "looks forward to the revival of normal relations between English and German scholars, and I desire that it may come without delay." Meanwhile, international organisation of scholarship need not be suspended, and we can work in full accord with our Allies. As a result of a meeting held in Paris in 1919 a series of proposals for future work was submitted by the representatives of the nations present. Sir F. Kenyon's review of these proposals deserves careful consideration.

THE calendar of the West of Scotland Agricultural College for the session 1920–21 has just been received. The college undertakes to give instruction in general agriculture, dairying, forestry, horticulture, and poultry keeping to farmers, teachers, and grocers as well as to students studying for the regular diplomas, certificates, and degrees. The course provided for farmers is held during the winter months and completed in one session; it is intended for the sons of farmers who are unable to take full-time courses. At the grocers' class, held in conjunction with the Glasgow Grocers' and Provision Merchants' Association, the lectures deal principally with milk, butter and butter-making, cheese and cheese-making, bacon, and eggs. For full-time students courses are provided which lead to college certificates and diplomas in agriculture, dairying, forestry, and horticulture and to the various national diplomas which are granted, while lectures in preparation for the degree of B.Sc. (Glasgow) are also given. The year is divided into two terms, a winter session which is held in Glasgow, and a summer session spent at the experimental schools at Kilmarnock. Evening lectures are available, and a certain amount of extension work in the form of lecturing at local institutes, conducting experiments, giving expert advice to farmers, etc., is also done.

A LARGE and important part of the extension work of most of the universities, colleges, and departments of education in the United States of America is done by correspondence methods (Bureau of Education, Bulletin No. 10, 1920). A list of the institutions developing this means of satisfying the desire for knowledge contains no fewer than thirty-eight universities. Seventy-three institutions are given in all, of which sixty-one are supported by public funds, and they are conducting correspondence courses for nearly one hundred thousand students. The Massachusetts Board of Education has provided some figures which show the motives actuating the pupils who enrolled for their correspondence courses, and also their previous educational history. More than 50 per cent. undertook courses in the hope of immediate practical gain, while only 22 per cent. began the work from motives of culture or enjoyment; the educational history of the pupils showed that 49 per cent. came from secondary schools, and 35 per cent. had received elementary education only. At the same institution 76 per cent. of those who enrolled for correspondence classes were above school-age; the average age was 26·3 years. The results obtained from studies of the ages of correspondence students in the University of Wisconsin, Indiana University, and other institutions differ little from those obtained in Massachusetts.

THE University Colleges of Newcastle-upon-Tyne—the College of Medicine and Armstrong College, both of which are units of the University of Durham—have launched an appeal to the district they serve for 500,000*l.* A large committee representing the four northern counties has been set up, under the presidency of Viscount Grey of Fallodon, and at a recent meeting, at which the Duke of Northumberland acted as chairman, this committee pledged itself to do all in its power to relieve the colleges from their present embarrassment. The financial position of Armstrong College is little short of desperate. In July, 1921, the college will be faced with an annual recurring deficit of more than 19,000*l.*; the salaries of the staff, though they have already been augmented, are still far too low; it has been found impossible to keep equipment up to date; and students have had to be refused admittance in large numbers. This college, the only university college between Leeds and Edinburgh which teaches science, is faced with bankruptcy. The situation of the College of Medicine, though less serious financially, is also unsatisfactory. It is badly hampered by lack of accommodation, and unable to develop its teaching to the full along modern lines. Believing that their needs have only to be made widely known to their district to be relieved, the two colleges have thrown themselves upon the generosity of Tyneside and the surrounding counties.

A PUBLIC meeting was held on Thursday, November 25, at the Leeds Town Hall, under the presidency of the Lord Mayor, to inaugurate an appeal for funds for the University of Leeds. The University is asking the public of Yorkshire, and others interested in the progress of higher education in the county, for 500,000*l.*, and the Vice-Chancellor (Sir Michael Sadler) was able to announce to the meeting that towards this fund gifts amounting to 112,800*l.* had already been received or promised. Amongst those who spoke in support of the appeal were representatives of local authorities, who contribute largely to the revenue of the University, and a number of prominent professional and business men. The needs of the University for additional funds were explained at the beginning of the meeting by the chairman of the council (Mr. Arthur G. Lupton), the treasurer (the Hon. Rupert Beckett), the Vice-Chancellor, and Prof. Smithells. The number of students in the University is now nearly three times as large as before the war. Most of the departments are overcrowded, and the annual expenditure of the University has enormously increased as a necessary consequence of the new conditions created by the war. New laboratories are required in nearly all the University's departments of pure and applied science and for the school of medicine, and new buildings are needed for the department of agriculture, the school of dentistry, the University library, the Students' Union and gymnasium, and as halls of residence for men and for women students. A large addition to the general endowment fund of the University is also desired.

Societies and Academies.

LONDON.

Royal Society, November 18.—Sir J. J. Thomson, president, in the chair.—Sir A. **Schuster**: The absorption and scattering of light. The paper is based on the generally accepted theory that refraction and dispersion are caused by the oscillations of electric resonators embedded in the medium through which the light passes. With homogeneous light each resonator responds with a forced oscillation, together with a motion following the laws of free oscillations, and gradually dying out. If white light falls on the medium the forced oscillation has to be replaced by an integral and other terms have to be added that are due to disturbances caused by neighbouring molecules. The equation for the displacement of an oscillator then takes the form:

$$z = \int_0^\infty \mathrm{E} f(n, w) \cos(wt - \epsilon)\, dw + \Sigma \mathrm{C}_s e^{-\kappa(t-t_s)} \sin \sqrt{n^2 - \kappa^2}\,(t - t_s).$$

The principal result of the paper is that all the terms of this equation are spectroscopically identical. If the proper value for $f(n, w)$ be introduced, and if E be regarded as constant, then the integral in the first term of the right-hand side is merely the analytical representation by Fourier's integral of any of the terms of the summation, with a proper adjustment of ϵ and t_s. As it stands, it represents a motion beginning at time $t=0$ and continuing according to the laws of a damped oscillator. The mechanism of scattering and absorption is discussed, and Lord Rayleigh's equation for the coefficient of extinction in a scattering medium is obtained in a more vigorous manner, so as to include cases where $\mu - 1$ is not necessarily small.—Prof. O. W. **Richardson**: The emission of electrons under the influence of chemical action. The electron currents to a surrounding metal electrode from spherical drops of the liquid alloy of sodium and potassium under the influence of chemical action with a number of gases have been investigated and measured under various conditions. The gas which has been studied most is phosgene ($COCl_2$), then, in decreasing order, Cl_2, H_2O, and HCl. In all cases the relation between the current and the applied potential difference is of the same general character. When proper allowance is made for the contact potential difference between the two metal surfaces it is found that the electron currents are nearly constant for small accelerating electric fields. Thus, as in the case of photo-electric emission, the saturation value of the current is reached with a potential difference very close to zero. With retarding fields the currents fall off rapidly as the applied potential difference increases. Like similar thermionic electron currents, they approach the voltage axis gradually and not sharply, as in the photo-electric case. The true zero on the voltage scale is difficult to determine on account of fluctuations in the contact potential difference. In the case of $COCl_2$ it has been possible to locate the zero to within 0·10 volt by a photo-electric method. The proportion of the chemically emitted electrons the kinetic energy of which lies between u and $u+du$ is very closely represented by

$$\frac{udu}{k^2T^2}e^{-u/kT}$$

where k is Boltzmann's constant and T is a certain temperature. For the case of $COCl_2$, T is near 3300° K, and for the case of Cl_2, T is about 4900° K. The formula above represents a Maxwell distribution for the temperature T. Thus the distribution of kinetic energy among the chemically emitted electrons is the same as that among the molecules of a gas at the uniform temperature T.—Dr. A. E. **Oxley**: Magnetism and atomic structure. This communication is an extension of former papers on "The Influence of Molecular Constitution and Temperature on Magnetic Susceptibility" (Phil. Trans. Roy. Soc., vol. ccxiv., A, 1914; vol. ccxv., A, 1915; and vol. ccxx., A, 1920). From Tyndall's work and recent experiments of the author on the characteristic deportment of diamagnetic and paramagnetic crystals in the magnetic field, it appears that in non-ionised crystal structures the fundamental unit of the space lattice is the molecule. It is shown that the electron orbits in atoms must be distributed in space round the nucleus, each electron describing a small orbit, or alternatively the electron itself may be a complex unit endowed with magnetic properties. In either case the distribution must be such that the aggregate projected area of the electron orbits on a plane perpendicular to the principal cleavage is a maximum in both diamagnetic and paramagnetic crystals. This result is consistent with a closer packing of the molecules in a direction parallel to the principal cleavage. In crystals of the simple cubic form X-ray analysis has indicated that the structure is an ionised-atomic one, and the cleavages are all of equal value. Such crystals show no appreciable structural deportment in the magnetic field. The above views relating to electron distribution are consistent with the cubical atom theory of Lewis and Langmuir, but not with Bohr's theory. The coupling forces between atoms and molecules in non-ionised crystals are due to the mutual magnetic induction between pairs of electron orbits. A model of the hydrogen molecule is given, in which the arrangement of the coupling units determines a diamagnetic molecule as required by experiment. It is considered that the above views and those of Bohr may eventually be brought into line by a fuller recognition of the possible differences between radiating and non-radiating matter.—Prof. A. O. **Rankine**: The proximity of atoms in gaseous molecules. In this investigation a close examination is made of the relations between the estimates of atomic diameters obtained by Prof. W. L. Bragg from X-ray crystal measurements and those deduced from the kinetic theory of gases. The examination is carried out from the point of view of the Lewis-Langmuir molecular theory. It is shown that if, for example, a hypothetical molecule be constructed of two argon atoms with their centres separated by the distance demanded by Prof. W. L. Bragg's figures, the behaviour of such molecules in thermal agitation would be almost identical with the actual behaviour of chlorine molecules. Similar relations are shown to exist for the pairs of gases neon-oxygen, krypton-bromine, and xenon-iodine. The following conclusions are regarded as justified: (*a*) There is substantial *quantitative* agreement between the estimates of atomic dimensions deduced from X-ray crystal measurements and from the kinetic theory of gases. (*b*) In size and shape the atoms of the monatomic inert elements are nearly indistinguishable from the atoms respectively of the neighbouring diatomic elements in the periodic table. (*c*) The Lewis-Langmuir molecular theory accounts satisfactorily for the kinetic behaviour of the molecules of oxygen, chlorine, bromine, and iodine in relation to the behaviour of the corresponding inert atoms neon, argon, krypton, and xenon.—Prof. A. O. **Rankine**: The similarity between carbon dioxide and nitrous oxide. The two gases in question have been shown by Langmuir to have almost identical physical properties. In particular, they have the same viscosity, and the application of modern kinetic theory indicates that their molecules have the same size and shape. In the present paper it is shown, by the extension of methods already described by the author, that the kinetic behaviour of the molecules of both CO_2 and N_2O is consistent with their being identical in size and shape with three neon atoms in line and contiguous, *i.e.* with outer electron shells touching. This is in accordance with Langmuir's view of the constitution of these molecules.—Dr. A. M. **Williams**: Forces in surface films. I.: Theoretical considerations. II.: Experimental observations and calculations. III.: The charge on colloids. I. and II.: Attention is directed to the effects of (i) accessibility of surface and (ii) adsorption on the apparent specific volume of finely divided solids. A simple theory of these effects is developed, with which observations are in agreement. The true specific volume of a specimen of charcoal, which appeared to be 0·51 in water and 0·46 in chloroform, was evaluated as 0·67 c.c. per gm. The attractive pressure on the surface film on the charcoal was calculated and found to be of the order of 10,000 atmospheres, while the internal pressure of the charcoal itself was evaluated as of the order of 50,000 atmospheres. III.: It is shown that compressive forces of the order previously determined may give rise in the adsorption layer to a diffusion potential difference of the magnitude observed in the case of suspensoids. The influence of the diffusion of hydrogen- and hydroxyl-ions on the potential difference is emphasised, and the neutralisation of the charge on suspensoids and their consequent precipitation explained in terms of diffusion potential.

Physical Society, November 12.—Sir W. H. Bragg, president, in the chair.—Dr. F. H. **Goucher**: Ionisation and excitation of radiation by electron impact in helium. Measurements have been made of the critical potentials for helium by the method used in the experiments of Davis and Goucher, these being compared with the ionising potential of mercury vapour taken as a standard. Assuming the ionising potential of mercury to be 10·4 volts, two critical potentials occur in helium, one at about 20 volts and the other at about 26 volts. These critical values agree well with those obtained by Horton and Davies. The effect of radiation alone on the metal parts of the apparatus was studied under conditions which would yield evidence of use in the interpretation of the results obtained when the production of both ionisation and radiation was taking place simultaneously. The conclusion was drawn that the lower critical potential was a radiation potential, though some ionisation was produced also at this potential. This, however, was attributed to the presence of impurity, probably hydrogen. The higher critical potential was that at which ionisation took place.—J. **Guild**: The location of interference fringes. The conditions under which interference fringes, produced by reflection of light from the two surfaces of a "thick plate," are visible to an observer. The treatment lays stress on the physical significance of the term "location" as applied to interference fringes and on the dependence of the observed phenomena on the conditions of observation. For a broad source of light a formula is obtained which is equivalent to that derived by Michelson. For a joint source of light at infinity it is shown that the fringes obtainable are equally visible at all distances from the plate.—J. **Guild**: Fringe systems in uncompensated interferometers. An investigation of the form of the fringe system observable at infinity, or in the focal plane of a telescope, when a broad source is employed with a Michelson interferometer in which the glass paths of the two interfering beams are not equal. The fringes may be elliptical or hyperbolic, with circles and straight lines as special cases. In the recently developed method of using the instrument for optical testing, the fringes due to a joint source at infinity are employed. It is shown that the form of the fringes in this case are unaffected by lack of compensation, but that the visibility of the fringes is conditioned by the nature of the fringe system due to a broad source.—Dr. G. **Barr**: A new relay for heavy currents. The action of the relay depends on the fact that no arc can be maintained between mercury electrodes in hydrogen. One lead is brought to mercury contained in a vertical tube within a solenoid. An iron rod, at the upper end of which is a glass cup floats in the mercury. The cup also contains mercury, and the other lead is connected to an iron rod which dips into this. When no current flows in the solenoid the rim of the cup is about 1 cm. above the level of the main body of mercury. When the relay current (about 0·03 ampere) is running the iron rod is sucked down until the rim of the cup is submerged by about 0·5 cm. The space above the mercury contains hydrogen. The relay can be used to break quite large currents (20 amperes) without much spark.

EDINBURGH.

Royal Society, November 1.—Prof. F. O. Bower, president, in the chair.—Three connected papers by Dr. J. **Rennie**, Miss Elsie **Harvey**, and B. **White**: The Isle of Wight bee disease. The results of these investigations, which were being carried out in the Parasitical Laboratory at Aberdeen, showed that the so-called Isle of Wight disease was due to a small mite living in the respiratory system of the bee. This was contrary to the views advanced some eight years ago by workers in England, who claimed that the causal organism was a protozoon named *Nosema apis*. Mr. Anderson, of Aberdeen, was the first to call in question this hypothesis, and the series of papers now presented established the existence of a new type of parasitism in bees of a remarkable kind. The small mite which was the cause of the disease belonged to the genus Tarsenemus. It was highly specialised in structure, was bred within the bee, and was confined to an extremely limited, but very important, region of its breathing system. Within the space of a few cubic millimetres scores of these creatures might be seen in all stages of development, sometimes packed in dense columns so as to cut off effectually the air-supply from the surrounding organs. The detailed pathology described in Mr. White's paper proved the destructive character of the parasites' habits. Thousands of bees had been examined from large numbers of stocks throughout the country, and it had been found that every stock reported by trustworthy beekepers or certified by the investigators as suffering from the disease harboured this parasite. Similarly, every individual bee known from its stock-history and individual symptoms to be suffering from the disease was likewise found to contain these parasites and to exhibit the internal disorders which caused the disabling symptoms. The investigators stated that they were now able to diagnose the disease in its earliest stages while the bees were capable of flying and foraging. Miss Harvey's researches showed that infection appeared to occur mainly in the hive, the conditions of the cluster making this comparatively easy. Mites had been obtained from the outside of the bee apparently on their migratory passage. Tarsenemus included several species destructive to plants, and there were some which have been found in malignant growths in man and other animals. The bee parasite was more closely allied to the latter group. Many bees from different countries outside Great Britain have been examined, and so far Tarsenemus has not been found in these. All the evidence hitherto obtained points to the parasite being peculiar to this country, coinciding with the general testimony regarding the insular character of the Isle of Wight disease. This name had long been regarded as unsatisfactory, and "acarine disease" was proposed as more appropriate. In view of the great practical interest taken by Mr. A. H. E. Wood, of Glassel, in the work of the research, Dr. Rennie proposed to designate the new species *Tarsenemus Woodi*. To Mr. Wood and to the Development Commissioners special recognition was due for having provided in equal measure funds necessary to finance the investigation, and the authors also record their high appreciation of the support of beekeepers throughout the country in supplying bees and other assistance so essential for the successful conduct of the research.—Prof. J. H. M. **Wedderburn**: The equations of motion of a single particle.

PARIS.

Academy of Sciences, November 8.—M. Henri Deslandres in the chair.—L. **Lecornu**: The permanent movements of liquids.—P. **Termier** and W. **Kilian**: The western edge of the glittering schists in the Franco-Italian Alps between Haute-Maurienne and Haut-Queyras. A discussion of the question as to whether the contact between these schists and the Briançon series is normal or abnormal. A careful study of more than 100 km. shows that the contact of these two strata has none of the characters of a normal contact, and the idea of a stratigraphical continuity is highly improbable.—L. **Lumière**: The photographic representation of a solid in space. Photostereo-synthesis.—H. **Parenty** and G. **Vandamme**: Utilisation of the energy of tides and waves. A description of an arrangement of cells made of reinforced concrete, by means of which air is compressed or rarefied by the shock of the waves. The apparatus has been constructed and gives pressures of 2–3 kg.—J. **de Lassus**: A transmission of mechanical energy utilising an invariable mass of gas in closed circuit.—A. **Danjon**: A new variable star of short period. The star *d* Cygnus varies in magnitude from 5·16 to 5·36, and the passage from maximum to minimum may be observed during one evening.—L. **Dunoyer**: Remarks on an article by Irving Langmuir and on another by R. W. Wood. A question of priority—E. **Jouguet**: Application of the Carnot-Clausius principle to waves of shock in elastic bodies.—R. **Biquard**: Abnormal indications furnished by radiochromometers with very penetrating X-rays. The principle upon which Benoît's radio-chromometer depends is not valid for the X-rays from a Coolidge tube under a potential of 60,000 volts or higher, and the use of this instrument should be confined to the measurement of X-rays of medium or low penetration such as those utilised in medical radiography or superficial radio-therapy.—L. and E. **Bloch**: The spark spectra of mercury, copper, zinc, and thallium in the extreme ultra-violet. The measurements were made with a prism spectrograph, and the wave-lengths given are based on Lyman's data obtained with a grating. New lines are given for all four metals.—C. **Raveau**: The determination of the number of independent components. The rule of M. Dubreuil; the action of water on a mixture of salts.—J. B. **Senderens**: The catalytic dehydration of fermentation amyl alcohol. Catalysis by aluminium silicate at 340° to 350° C. gives a mixture of three amylenes, and the proportion in which these are present depends on the length of time the catalyst has been in use. The first litre of amylenes collected contained 93 per cent. of amylene soluble in diluted sulphuric acid, the third litre only 75 per cent.—R. **Cornubert**: The spectrochemical study of the α-allyl- and α-allylmethyl-*cyclo*hexanones.—L. **Duparc** and G. **Favre**: The deposit of oolitic iron ore at Ain-Babouche (Algeria).—H. **Jumelle**: The katoka, a Madagascan tree with edible seeds. The tree is a new species of the genus Treculia, and is named *Treculia Perrieri*. It is abundant in the west of Madagascar and produces a good wood and edible seeds. The latter are consumed by the natives as food, and have been imported into France for the extraction of their oil.—H. **Bouygues**: The terminal meristem of the stem and its division into regions.—P. **Lesage**: Evaporometers and the motion of fluids through membranes.—A. **Damiens**: The bromine and chlorine existing normally in animal tissues. Bromine was found in all the organs examined, except in two or three cases where the quantities of material available were too small. The ratio of bromine to chlorine in the organs of any given animal is sensibly constant, and is of the order 0·001 to 0·002.—L. **Mercier**: Variation in the number of the fibres of the longitudinal vibrator muscles in *Chersodromia hirta*. Loss of the power of flight.—C. **Julin** and A. **Robert**: Organogenesis in the blastozoites of Perophora.—T. **Tommasina**: Remarks on the note by M. Louis Besson on the relation between the meteorological elements and the number of deaths by inflammatory diseases of the respiratory organs at Paris.

Books Received.

The Birds of the British Isles and their Eggs. By T. A. Coward. Second Series: Comprising Families Anatidæ to Tetraonidæ. Pp. vii+376+159 plates. (London and New York: F. Warne and Co., Ltd.) 12*s*. 6*d*. net.

Considérations sur l'Etre Vivant. By C. Janet. Première Partie. Pp. 80+1 planche. (Beauvais: A. Dumontier.)

The Annual of the British School at Athens. No. xxiii., Session 1918–19. Pp. xvi+260+xvi plates. (London: Macmillan and Co., Ltd.) 30*s*. net.

Anxiety Hysteria: Modern Views on some Neuroses. By Dr. C. H. L. Rixon and D. Matthew. Pp. xi+124. (London: H. K. Lewis and Co., Ltd.) 4*s*. 6*d*. net.

From the Unconscious to the Conscious. By G. Geley. Translated by Stanley de Brath. Pp. xxviii+328. (London: W. Collins, Sons and Co., Ltd.) 17*s*. 6*d*. net.

Functional Mental Illnesses and the Interdependence of the Sympathetic and Central Nervous Systems in Relation to the Psychoneuroses. By Dr. R. G. Rows and Dr. D. Orr. Pp. 63. (Edinburgh and London: Oliver and Boyd.) 3*s*. 6*d*.

Äther und Relativitäts-Theorie. Rede gehalten am 5 Mai 1920 an der Reichs-Universitäts zu Leiden. By A. Einstein. Pp. 15. (Berlin: J. Springer.) 2.80 marks.

The Progress to Geography. By Dr. R. Wilson. Stage 1: Pictures and Conversations. Pp. 144. 2*s*. 6*d*. Stage 2: More Pictures and Conversations. Pp. 176. 3*s*. (London: Macmillan and Co., Ltd.)

Ministry of Health. Annual Report of the Chief Medical Officer, 1919–20. (Cmd. 978.) Pp. 393. (London: H.M. Stationery Office.) 3*s*. 6*d*. net.

Memoirs of the Geological Survey. Special Reports on the Mineral Resources of Great Britain. Vol. vii.: Mineral Oil, Kimmeridge Oil-Shale, Lignites, Jets, Cannel Coals, Natural Gas. By Sir A. Strahan. Second edition. Pp. iv+125. (London: E. Stanford, Ltd.; Southampton: Ordnance Survey Office.) 5*s*. net.

Productive Soils. The Fundamentals of Successful Soil Management and Profitable Crop Production. By W. W. Weir. Pp. xvi+398. (Philadelphia and London: J. B. Lippincott Co.) 10*s*. 6*d*. net.

An Introduction to the Structure and Reproduction of Plants. By Prof. F. E. Fritch and Dr. E. J. Salisbury. Pp. viii+458. (London: G. Bell and Sons, Ltd.) 15*s*. net.

British Plants: Their Biology and Ecology. By J. F. Beirs and H. J. Jeffery. Second edition. Pp. xii+346. (London: Methuen and Co., Ltd.) 7*s*. 6*d*.

Public Health Chemical Analysis. By R. C. Frederick and Dr. A. Forster. Pp. viii+305. (London: Constable and Co., Ltd.) 21*s*. net.

Hydraulics with Working Tables. By E. S. Bellasis. Third edition. Pp. viii+348. (London: Chapman and Hall, Ltd.) 18*s*. net.

Practical Physiological Chemistry. By S. W. Cole. Sixth edition. Pp. xvi+405. (Cambridge: W. Heffer and Sons, Ltd.; London: Simpkin, Marshall and Co., Ltd.) 16*s*.

Collected Papers on the Psychology of Phantasy. By Dr. C. E. Long. Pp. xii+216. (London: Baillière, Tindall and Cox.) 10*s*. 6*d*. net.

The Origin of Man and of his Superstitions. By C. Read. Pp. xii+350. (Cambridge: at the University Press.) 18*s*. net.

Maryland Geological Survey. Cambrian and Ordovician. Pp. 424+lviii plates. (Baltimore: Johns Hopkins Press.)

Report on the Danish Oceanographical Expeditions, 1908–1910, to the Mediterranean and Adjacent Seas. By Dr. Johs. Schmidt. No. 6. Vol. ii.: Biology. Pp. 140+110. (Copenhagen: A. F. Høst and Son.)

La Chimie et la Guerre. Science et Avenir. By Prof. C. Moureu. Pp. iii+384. (Paris: Masson et Cie.) 10 francs.

Diary of Societies.

THURSDAY, DECEMBER 2.

ROYAL AERONAUTICAL SOCIETY (at Royal Society of Arts), at 5.—Major G. H. Scott: Airship Piloting.—Flight-Lieutenant F. L. C. Butcher: Airship Mooring.

CHILD-STUDY SOCIETY (at Royal Sanitary Institute), at 6.—Dr. W. Brown: The Value of Suggestion in Education.

CHEMICAL SOCIETY, at 8.—Sir Prafulla C. Rây: Varying Valency of Platinum with Respect to Mercaptanic Radicles.—H. E. Cox: The Influence of the Solvent on the Velocity of certain Reactions. Part II. Temperature Coefficients. A Test of the Radiation Hypothesis.—K. J. P. Orton and P. V. McKie: Preparation of Chloropicrin from Picric Acid and Trinitrotoluenes.

ROYAL SOCIETY OF MEDICINE (Obstetrics and Gynæcology Section), at 8.—C. White: Sodium Bicarbonate Tolerance in the Toxæmias of Pregnancy.—Major C. A. F. Hingston: The Necessity for the Reduction of Blood Pressure in Eclampsia.—Dr. R. W. Johnstone and Dr. J. Young: Case of Accidental Hæmorrhage associated with Eclampsia.—Dr. J. Young and Dr. D. Miller: Further Observations on the Etiology of Eclampsia and the Pre-eclamptic State.

FRIDAY, DECEMBER 3.

ROYAL SOCIETY OF MEDICINE (Laryngology Section), at 4.45.
ROYAL ASTRONOMICAL SOCIETY (Geophysical Discussion), at 5.—The Cause of Magnetic Storms.—In Chair: J. H. Jeans. Opener: Prof. F. A. Lindemann.—Other Speakers: Prof. S. Chapman, Dr. C. Chree, Rev. A. L. Cortie, Major G. M. Dobson, E. W. Maunder, C. S. Wright, and Others.
INSTITUTION OF MECHANICAL ENGINEERS, at 6.—Further Discussion on The Human Factor in Industry, by A. Ramsay.
INSTITUTION OF ELECTRICAL ENGINEERS (Students' Section) (at King's College), at 6.30.—A. Serner and Others: Discussion on The Modern Tendency to Trusts. Is it Beneficial?
JUNIOR INSTITUTION OF ENGINEERS (at Caxton Hall), at 8.—G. F. Shotter: Electrolysis as applied to the Measurement of Water.
ROYAL SOCIETY OF MEDICINE (Anæsthetics Section), at 8.30.—Informal Meeting.

SATURDAY, DECEMBER 4.

GILBERT WHITE FELLOWSHIP (at 6 Queen Square, W.C.1), at 3.—H. J. Elwes: The Primitive Races of Sheep in Great Britain.

MONDAY, DECEMBER 6.

VICTORIA INSTITUTE, at 4.30.—Dr. D. Anderson-Berry: The Psychology of Man, Experimentally Considered.
ROYAL COLLEGE OF SURGEONS OF ENGLAND, at 5.—Sir Berkeley Moynihan: The Surgery of the Diseases of the Spleen (Bradshaw Lecture).
ROYAL INSTITUTION OF GREAT BRITAIN, at 5.
SOCIETY OF ENGINEERS (Inc.) (at Geological Society), at 5.30.—H. Banks: Blackpool Sea Coast Defence Works.
ARISTOTELIAN SOCIETY (at University of London Club, 21 Gower Street), at 8.—Prof. W. P. Montague: Variation, Heredity, and Consciousness.
SOCIETY OF CHEMICAL INDUSTRY (London Section) (at Chemical Society), at 8.—Dr. H. Levinstein: The Dyestuff Industry.
ROYAL GEOGRAPHICAL SOCIETY (at Æolian Hall), at 8.30.—Major-Gen. L. C. Dunsterville: From Baghdad to the Caspian in 1918.
MEDICAL SOCIETY OF LONDON (at 11 Chandos Street, W.1), at 8.30.—The Surgical Treatment of Malignant Disease of the Colon, introduced by Sir Berkeley Moynihan, to be followed by Sir W. Arbuthnot Lane, Bt., G. Wright, L. Mummery, G. G. Turner, and H. W. Carson.

TUESDAY, DECEMBER 7.

ROYAL SOCIETY OF ARTS, at 4.30.—A. H. Ashbolt: The Trade of Australia During and After the War.
INSTITUTE OF INDUSTRIAL ADMINISTRATION (at Central Hall, Westminster), at 7.—R. Twelvetrees: Road Transport as an Aid to Industrial Management.
ROYAL SOCIETY OF MEDICINE (Surgery: Sub-section of Orthopædics), at 5.30.
ROYAL PHOTOGRAPHIC SOCIETY OF GREAT BRITAIN, at 7.—F. Martin-Duncan: Photomicrography from the Ordinary Photographer's Point of View: Exhibition of Various Forms of Photomicrographic Apparatus and Demonstration of Use.
ROYAL ANTHROPOLOGICAL INSTITUTE, at 8.15.—L. S. Palmer: Some Late Keltic Remains from a Mendip Cave.
SOCIOLOGICAL SOCIETY (at 65 Belgrave Road), at 8.15.—Major Douglas: The Mechanism of Consumer-Control.
ROYAL SOCIETY OF MEDICINE (Pathology Section) (at Laboratories of Medical Research Council, Mount Vernon, Hampstead), at 8.30.—Prof. L. Hill: The Measurement of the Capillary Blood Pressure.—Capt. S. R. Douglas: The Serological Races of the Cholera Vibrio.—Dr. W. Mair: Dobler's Bodies in Scarlet Fever and Pneumonia.—J. E. Barnard: The Use of Ultra-Violet Light in the Differentiation of Animal Tissues.—Dr. L. Colebrook: Actinomyces.—Major H. W. Acton: The Formation of the Gametocyte of Benign Tertian Malaria.—Dr. Lovatt Evans: A Method for the Determination of the Reaction of Blood.

WEDNESDAY, DECEMBER 8.

ROYAL SOCIETY OF ARTS, at 4.30.—E. A. Brayley Hodgetts: A Retrospect of the Personal Influence of Britons in Russia.
INSTITUTION OF AUTOMOBILE ENGINEERS (at Institution of Mechanical Engineers), at 8.

THURSDAY, DECEMBER 9.

ROYAL SOCIETY, at 4.30.—*Probable Papers*.—Lord Rayleigh: Doubly Refracting Structure of Silica Glass.—Prof. J. W. Nicholson and Prof. T. R. Merton: The Effect of Asymmetry on Wave-Length Determinations.—Prof. T. R. Merton: The Effect of Concentration on the Spectra of Luminous Gases.—Prof. E. Wilson: The Measurement of Low Magnetic Susceptibility by an Instrument of New Type.—Prof. W. T. David: The Internal Energy of Inflammable Mixtures of Coal-Gas and Air after Explosion.—Prof. A. McAulay: Multenions and Differential Invariants.
LINNEAN SOCIETY, at 5.—Prof. R. Newstead: Uganda Biology (Lantern Lecture).
LONDON MATHEMATICAL SOCIETY (at Royal Astronomical Society), at 5.—S. Beatty: The Algebraic Theory of Algebraic Functions of One Variable.—F. Debono: The Construction of Magic Squares.—Prof. A. S. Eddington: An Application of the Calculus of Tensors to the Theory of Finite Differences.—Prof. A. R. Forsyth: Developable Surfaces through Two Curves in Different Planes.—J. E. Jones: The Distribution of Energy in the Neighbourhood of a Vibrating Sphere.—L. J. Mordell: (1) The Reciprocity Formula for the Gauss's Sums in a Quadratic Field. (2) A New Class of Definite Integrals.—Prof. G. N. Watson: The Product of Two Hypergeometric Functions.—Prof. W. H. Young: (1) Integration over the Area of a Surface and Transformation of the Variables in a Multiple Integral. (2) A New Set of Conditions for a Formula for an Area.
ROYAL SOCIETY OF MEDICINE (Balneology and Climatology Section), at 5.15.—Dr. Max Porges: Mud Baths and Nephritis.—Dr. F. Hernaman-Johnson: The Importance of Combined Methods in Diagnosis and Treatment.—Dr. S. Burridge: Some Possible Ill-effects of Barium Waters.
INSTITUTION OF ELECTRICAL ENGINEERS (at Institution of Civil Engineers), at 6.—Adjourned Discussion on Papers by W. B. Woodhouse and R. O. Kapp on The Distribution of Electricity and Some Economic Aspects of E.H.T. Distribution by Underground Cables.
ROYAL SOCIETY OF MEDICINE (Neurology Section), at 8.30.—Dr. F. Buzzard: Tabes, its Early Recognition and Treatment.

FRIDAY, DECEMBER 10.

ASSOCIATION OF ECONOMIC BIOLOGISTS (in the Botanical Theatre, Imperial College of Science), at 2.30.—Exhibition of Specimens and Short Communications.—W. J. Dowson: Problems of Economic Biology in British East Africa.—Dr. M. C. Rayner: Nitrogen Fixation in the Ericaceæ.
ROYAL ASTRONOMICAL SOCIETY, at 5.
PHYSICAL SOCIETY OF LONDON, at 5.—J. St. V. Pletts: Some Slide Rule Improvements.—F. H. Newman: The Absorption of Gases in the Electric Discharge Tube.—F. H. Newman: A Sodium Vapour Electric Discharge Tube (with Demonstration).—N. A. Allen: The Current-Density in the Crater of the Carbon Arc.
ROYAL SOCIETY OF MEDICINE (Clinical Section), at 5.30.
INSTITUTION OF MECHANICAL ENGINEERS (Informal Meeting), at 7.
TECHNICAL INSPECTION ASSOCIATION (at Royal Society of Arts), at 7.30.—Dr. G. H. Gulliver: Some Features of Tensile Fractures.
ROYAL SOCIETY OF MEDICINE (Ophthalmology Section), at 8.30.

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