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A Proposed National Institute of Industrial Micro-biology.

IN no department of chemistry has greater progress been made during comparatively recent years than in biochemistry—the youngest and in some respects the most fascinating of the various branches into which chemical science has, for purposes of convenience, been partitioned. The beauty, the mystery, and the deep import of the phenomena with which biochemistry is concerned cannot fail to make a strong appeal to the scientific imagination, even at a time when brilliant and fundamental discoveries in other branches of chemistry are so insistently claiming our attention and exciting our admiration and wonder.

Even if familiarity does not necessarily breed contempt, it often has a strong tendency to beget indifference, and this, coupled with the fact that biochemical phenomena are not, as a rule, of an arresting or spectacular nature, probably accounts largely for the lack of interest shown by chemists in general for so many years in this field of chemical inquiry. It is, however, this very absence of all that is spectacular or suggestive of difficulty or effort that makes the biochemical or life-processes so wonderful and so worthy of our closest study.

When we compare the synthetical methods of our laboratories with those of Nature we cannot fail to be struck with the essential crudity of the former. Great as were the intellectual achievements involved in the synthesis of, say, indigo, alizarin, nicotine, or camphor, it is certain that those and many other natural compounds are manufactured by the plant in a much more efficient and less wasteful manner.

By a close study of the way in which living organisms perform their remarkable feats of building up and breaking down, organic chemists will, no doubt, be enabled in course of time to dispense very largely with their fusion pots and their autoclaves and to work more closely on the lines of the living cell, at any rate so far as the synthesis of naturally occurring compounds is concerned. To this end intensive study of the phenomena of colloidal chemistry and of the nature of enzyme action (including the function of "activators" and "accelerators") becomes of the highest moment. This aspect of the matter has recently received consideration in two important and very suggestive presidential addresses—that of Sir William Pope to the Society of Chemical Industry, in Montreal; and that of Dr. M. O. Forster to the chemistry section of the British Association, in Edinburgh. I may, perhaps, be permitted to point out that it also formed the *leit motif* of my recent Cantor lectures on "Micro-organisms and some of their Industrial Uses."

In the micro-organism as a living cell we have a chemical laboratory of the highest efficiency and of the most remarkable character, and could we but understand and imitate artificially the processes of synthesis and analysis which are so quietly and so regularly occurring in, say, a single cell of yeast, we should be not only within measurable distance of a new industrial organic chemistry, but also we should be a little nearer to an understanding of that greatest of all problems —the nature of life.

Whether, with the growth of chemical knowledge, the services of the living cell in connection with industrial operations will be ultimately dispensed with only the future can show, but certain it is that that time is still far distant. At present a number of important industries are more or less dependent on the activities of certain lowly organisms, and from the point of view of successful and efficient factory working alone, it is essential that we should possess a very thorough knowledge of the nature of those organisms and of the influence of environment on their chemical activities. From whatever point of view, therefore, we regard the study of industrial micro-biology, it is clear that its encouragement and development are of high national concern. Anyone who makes an unbiased survey of the work done in this domain in various parts of the world

cannot honestly feel satisfied with the contribution made by this country, especially when regard is had to our outstanding position as an industrial nation and to the immensity of our Empire and of our resources.

The disastrous indifference which we have for so long shown to the claims of scientific research appears now to be giving way to a feverish attempt to make up the leeway we have lost. It was in the hope that industrial micro-biology might participate in this new expenditure of energy that I was induced to make a special appeal for the foundation of a national institute in a paper read before the Society of Chemical Industry at the annual general meeting of the Society in July, 1919. At present the provision made for systematic instruction in industrial micro-biology, and for the study of the innumerable important problems on which it bears, is very inadequate, and there is not in this country nor, so far as I am aware, in the British Dominions, any institution devoted to a subject which is admittedly of such great technological importance. In connection with brewing and distilling, an immense amount of work has been, and is still being, done, but other industries in which micro-organisms play an important and even a predominant part have been left largely to take their chances, with—in some cases—the result that might easily have been predicted.

It is impossible, in the course of a short article such as this, to deal at any length with these various industries, or even to enumerate them all. I may, however, instance the manufacture of lactic and butyric acids, the wine, vinegar, and dairying industries, agriculture, baking, tanning, and the treatment of sewage, as among the more prominent. In addition to this the manufacture of enzyme preparations for many purposes is becoming daily of greater importance, and finally there is the question of the production of what may be termed synthetic food.

Assuming a national institute such as I have advocated to come into existence, it may be well to summarise very briefly the functions which it might usefully perform and the ground its activities might cover. The first and perhaps the most important object of a national institute would be to provide for the systematic prosecution of original research in connection with the above industries, and, in fact, with any industry in which micro-organisms or enzymes play an important part. That a great deal of very valuable work of this kind has been done and is now being done in this country is well known to all who are familiar with the subject, but the institutions in which this work is being carried out are scattered, and there can be no doubt that far better results could be obtained if the many closely related problems connected with the activity of organisms and of enzymes could be studied in a single institution adequately provided with all the necessary appliances and specimens, where the various workers in closely associated fields would have an opportunity of discussing their problems with one another.

In the next place the institute would serve as a centre for the specialised training of men intending to devote themselves to the teaching of micro-biology and biochemistry in our universities and technical schools, and also for the practical instruction of factory managers and other technical employés engaged in the various biological industries.

A further function which the proposed institute might fulfil would be that of providing breweries, distilleries, and other factories with any required organisms in pure culture and in sufficiently large quantities for industrial purposes. Facilities of this kind exist to some extent in France, and, I believe, to an even greater extent in Germany, but they are practically non-existent in this country.

Then again the institute would serve to house as complete a collection of industrial micro-organisms in pure culture as could be got together. Recently something in this direction has been done in the formation, by the Medical Research Council, of the national collection of type cultures at the Lister Institute, under the directorship of Dr. Ledingham, but although this and other similar collections will certainly be of considerable use, they cannot take the place of the much more exhaustive and complete collection which it would be one of the main functions of a national institute to accumulate.

I am aware that the labour involved in maintaining such a collection as I am indicating would be considerable, but it is of the routine kind, necessitating the employment merely of a few carefully trained laboratory attendants working under the supervision of the curator of the collection.

The institute would further serve as a central biochemical library. At the present time steps are being taken to form one large library devoted to chemical literature, and there is a very general feeling that all overlapping and unnecessary multi-

plication should be avoided. With this policy of concentration I am in the fullest agreement, but I think it will be generally admitted by all who know that the literature of the subject with which I am dealing is of a very highly specialised character; that it is, of course, more largely biological than chemical; and that many of the most important volumes and some even of the periodical journals are not, as a matter of fact, readily obtainable in any of our existing libraries. The general demand for certain works dealing with micro-biology is too small, and the books themselves are, perhaps, too costly and too highly specialised to appeal to the majority of the members of the library committees of our scientific societies.

Finally (and this would probably not be one of the least important of its functions) the proposed institute would serve as a central home for British micro-biological science and as the institute to which all workers in this field of natural knowledge, in every part of our Dominions, could apply for information, to which they could send rare specimens for identification or for investigation, and to which they could—subject to proper safeguards in the matter of priority—communicate any discovery of importance.

The subject, in its botanical aspects, is not one with which I can claim anything more than a very limited acquaintance, but I have some reason to believe that in our Colonies and overseas Dominions there are mycologists who would experience the advantage of such an institution, and who, while obtaining information themselves, might render great national service by contributing to our knowledge of the nature of many fungoid plant-diseases.

I am well aware of the admirable work in the domain of industrial micro-biology which is being done in a number of isolated institutions in this country, as well as in one or two well-known American colleges, in the Pasteur Institute in Paris, in the Institute for Fermentation Industries in Berlin, in the Carlsberg Laboratory in Copenhagen, and elsewhere. Each of these institutions, however, deals with this immense subject in certain of its aspects only, and, as compared with the scheme which I am advocating, they suffer from the great disadvantage that there is no co-ordination, and that, consequently, a combined attack on any of the big problems which are calling for solution is rendered very difficult, if not impossible. Among such problems I might instance the biochemical conversion of cellulose into fermentable sugar, from which industrial alcohol might be prepared on one hand, or synthetic foods on the other.

A few years before the outbreak of war the formation of a national institution somewhat on the lines I have suggested in this article was advocated by Paul Lindner, of the Institute for Fermentation Industries in Berlin. It need scarcely be said that the institute Lindner advocated would have had its home in Germany, and I feel strongly that it behoves us in this country to take steps to establish, on British soil, an institution which, although primarily intended to meet the needs of British workers, might ultimately receive the support of many of our American and Continental colleagues.

I know that one of the greatest difficulties, especially at the present time, in connection with the scheme will be that of obtaining sufficient money for the purpose. It seems to me, however, that a beginning might be made in a very modest manner. A large and expensive building would not, in the first instance, be necessary or even desirable, for in a matter of this kind much more would depend upon the selection of the right men than upon the size of the building or even upon the perfection of its equipment. Possibly some existing building, preferably in proximity to one of our university colleges, would be available. A very important point, however, is that it should be a *separate national institute*, and not a mere department of some existing teaching institution.

A. CHASTON CHAPMAN.

Currents of Mathematical Thought.

L'Idéal Scientifique des Mathématiciens: Dans l'Antiquité et dans les Temps Modernes. By Prof. Pierre Boutroux. (Nouvelle Collection scientifique.) Pp. 274. (Paris: Félix Alcan, 1920.) 8 francs net.

THE aim of this work has been carefully explained by the author, and the reader must continually bear that fact in mind. The book is not a history of mathematics; it is not an account of striking discoveries, or a criticism of mathematical methods, as such. It is an attempt, in the light of our present knowledge, to trace the principal currents of thought by which professional mathematicians during different periods have been consciously or unconsciously influenced. No hard-and-fast boundary lines have been laid down; it is merely for the sake of convenience

that the whole time considered has been divided into three successive stages. The first of these ends when the classical Greek methods had practically lost their prestige and fertility; the second when (at the end of the eighteenth century) the new methods introduced by Descartes, Newton, Leibniz, and Euler seemed to have reached in like manner the limit of their powers and to be incapable of suggesting really new and important fields of research.

Now that so much good work has been done on Greek mathematics we can realise with fair accuracy what ideas the Greek mathematician had of his subject. It included the arithmetic of whole numbers as well as geometry, and for the Pythagoreans at any rate the former branch was the most fundamental. By the time of Euclid the Greeks had a perfect theory of proportion, and a method of exhaustion capable of solving problems for which we now use integral calculus. In Apollonius's "Conics" we have numerous propositions which are so easily translated into a modern algebraical form that one is almost tempted to think that the Greeks anticipated Descartes' analytical method. This, however, is not the case; and in the same way it is a mistake to fancy that they had a theory of irrational numbers. The discovery of incommensurable quantities led to a theory of proportion applicable to them, but the ratio of two similar quantities was never regarded as a number even if one of the quantities was an exact multiple of the other. Computation and measurement as such did not form part of mathematics; limitations of construction, such as those of Euclid's "Elements," seem due to a mixture of æsthetic and philosophical considerations. Archimedes' tract "On Method" shows that the greatest Greek mathematicians did not disdain the use of mechanical considerations as an aid to mathematical research; but they never were contented with a mechanical proof, and always tried to replace it by one strictly mathematical in their sense of the term.

Coming now to the second period, Prof. Boutroux considers that the great innovation of the seventeenth century does not consist in the use of new methods such as the infinitesimal calculus, but rather in the development of the notion of "function," especially in the form of an infinite series. Few things are more interesting than the history of the mathematical term "function." For a long period all the functions actually considered were those expressible by power-series. Even these were discussed in what would now be called a scandalously superficial way. In spite of the fact that as early as the time of the Bernoullis the problem of vibrating strings led to a prolonged discussion as to the possible or proper representation of so-called "arbitrary" functions, the subject was left "wropped up in mystery": it was often tacitly assumed that a power-series representation, at least for some intervals, was always possible if only it could be found. Fourier's introduction of trigonometrical series and his bold application of them to physical problems gave a sort of electrical shock to the mathematical world, and the use of complex quantities was still regarded by the orthodox as a sort of juggling trick which led to correct results in a quite inscrutable way.

The beginning of the modern period may be conveniently marked by Abel's memoir on the binomial series; in this we have for the first time a correct and rigorous treatment of an analytical function. After this, in the hands of Riemann, Dirichlet and others the subject made great strides, and the vast subject of the classification of functions has been attacked with a gratifying measure of success.

In tracing the currents of mathematical thought the author has frequently to deal with controversial matters on which he cannot pretend to give more than a plausible opinion. Perhaps the most important of these depends on the definition of mathematics. In our own opinion it is best for the present not to attempt any formal definition of mathematics, but to be content with the international schedule on which the Royal Society Subject-Index is based. So long as it is agreed to include such things as the theory of groups on one hand, and abstract dynamics on the other, a formal definition is practically impossible. But there is one point on which a difference of opinion is both significant and important. Is mathematics a science in the true sense, or is it an organised method of a special type reducible almost entirely to a branch of symbolic logic? We are very glad to see that Prof. Boutroux emphatically adopts the former view. To him, as to us, mathematics proceeds from a body of indefinable data which it discusses by means of special methods peculiarly its own, while its general method is simply that of all scientific research. The school of which Mr. Bertrand Russell may be taken as a representative has performed a great service by its critical discussion of what we may call mathematical first principles; but few of its members, we fancy, would claim that it has contributed to mathematical theory. At any rate the great body of progressive mathematicians have refused to admit any such claim; and we may venture to suggest one reason for

their doing so, a reason which can be appreciated by anyone of a mathematical turn of mind. There are certain ideas, such as those of the shape and connectivity of surfaces, which are extremely difficult, if not impossible, to reduce to arithmetical terms. The plain man will, we think, continue to assert that his concept of the shape of a sphere or an anchor ring is as clear as any that he has, independently of any arithmetical considerations, and this although in these cases analytical equations of the surfaces can be found; the same thing is true, in even greater measure, of Möbius's one-sided surface and its deformations.

Whether the reader of this book agrees with all the author's conclusions or not, he cannot but be grateful for the careful arguments by which they are supported. The last word on the subject has not been said, and vigorous controversy about it may be confidently expected; but whatever the final conclusion may be, Prof. Boutroux's work is likely to be regarded as a valuable contribution to the philosophy of mathematics. G. B. M.

Science and the Community.

From a Modern University: Some Aims and Aspirations of Science. By Prof. A. Smithells. Pp. 124. (London: Oxford University Press, 1921.) 12*s.* 6*d.* net.

WHATEVER Prof. Smithells has to say on the aims of education and aspirations of science is always worthy of attention, because it represents the wisdom of experience and the deliberations of a well-balanced mind. We are glad, therefore, that seven addresses, delivered by him on various occasions from 1906 to 1914, are here brought together in book-form, and we hope they will be widely read, particularly by members of the general public. The sub-title is a better index to the contents of the volume than is the main title, for the whole of the addresses are concerned with the relation of science to the community through education, industry, and other practical and intellectual activities. They state clearly and with dignity what science stands for in modern life, and their message cannot reach too extended a circle.

Prof. Smithells has decided views upon the place of science in education, and the significance of university work to industrial progress. In common with most university teachers, he holds that a broad and sound general education, in which science occupies a rightful part, is the best foundation upon which to build a university course, but he goes farther and urges with convincing iteration that universities serve the best purposes of industry when they treasure men of genius working in them purely for the advancement of natural knowledge and unfettered with considerations as to whether the instruction or research is directly profitable to industry or trade. "If," he says, "the sole purpose of our new universities were to make industry and commerce more effective instruments of either personal or national wealth, you might indeed find men to staff them, but you would not find men who were worthy of their hire, and you would have nothing that had a just claim to the title of a university."

The new universities have, no doubt, had a difficulty in convincing the business world around them that their essential function is the extension of knowledge into new fields, and not necessarily the improvement of the trade of the district in which they are situated, but they have mostly done so with gratifying success; and even in the ancient universities of this kingdom an obscurantist attitude towards scientific inquiry is not unknown. It is true that the caskets of the past are filled with treasures of fact, thought, and performance, but all that can be done in the social sciences is to reveal these products of human genius and action with the object of using them as a store of wisdom and experience from which guidance to policy or conduct may be gained. The experimental sciences, however, are particularly concerned with the discovery of things and principles never before known, and not with merely reconstructing past history. When Galileo first turned his small telescope towards the three stars in the Belt of Orion and the six in the Sword he saw in the field of view eighty stars which had never previously been looked upon by human eyes, and every such scientific discovery represents a similar expansion of the empire of knowledge—a Rosetta stone for the interpretation, not of human documents, but of the works of the Maker of the Universe.

When this distinction between literary records and scientific revelation is understood, no objection need be raised to the limitation of the "humanities" to matters relating to human affairs and human nature generally, though historically and actually experimental philosophers may claim to be humanists with as much right as do men of letters and students of social sciences. Prof. Smithells himself certainly belongs to this category, for he is no narrow pedant, but a man of wide interests and wise vision, and in almost every address in the present volume the key-note is sounded of science as a noble pursuit and an ethical influence. So much attention is now given to material results of scientific research that it is refreshing to find a representative of a modern

university, which has to look for support largely to business men, proclaiming over and over again that science teaching is not to be justified by works alone, but by the spirit of intellectual expansion. Yet while Prof. Smithells advocates science for its own sake as a necessary part of the curriculum in all stages of study, he does not overlook the fact that many great developments have had their origin in efforts to solve purely practical problems; and he illustrates this in one address by a sketch of Pasteur's work. He is, however, strongly opposed to the control of university teaching by technology, and says frankly: "I consider technical universities to be an educational mistake and a national danger of the first magnitude."

The attitude towards knowledge represented by this remark is characteristic of Prof. Smithells, whose message may perhaps be expressed by the phrase: "Foster the spirit of science, and the rest shall be given unto you." This is the exhortation alike to an Indian audience, to gas engineers, to journalists, to students of home science and household economics, and to the Workers' Educational Association. It is the *motif* of the whole composition, and discerning ears will distinguish it above the din of the market-place and the clanging of industrial hammers, and be stimulated by it. The best teaching of art, or literature, or music, is that which promotes appreciation of what is highest in each of them, and the same is true of science, whether the best be the revelation of a law of Nature through disinterested research, the creation of a new industry through scientific discovery, or the mental attitude developed by training in scientific method. Modern civilisation is built upon science, and a knowledge of its foundations is therefore essential to all who have power to determine the shape of the superstructure, otherwise it may be destroyed by its own strength. Prof. Smithells pleads eloquently and with inspiring conviction on behalf of natural knowledge and its human significance, and the cause to which he has devoted most of his life will be decidedly benefited if his advocacy of it is widely read.

William Osler.

Counsels and Ideals: From the Writings of William Osler. Second edition. Pp. xxiv + 355. (London: Oxford University Press, 1921.) 8*s.* 6*d.* net.

IT would be difficult to overpraise Osler. He was heart and soul in love with life—a man most lovable, courteous, gracious, of unfailing sympathy, hopeful, generous. Toronto, Montreal, Baltimore, Oxford—these universities were the stages of his work for mankind: a great teacher, a good example to all of us, a foremost representative of the science and art of medicine. He came from America to England as Mr. Lowell came, as an Ambassador: and by his culture, his devotion to the humanities, and his admirable gift of speaking well and writing well, he delighted Oxford as Lowell delighted London. It was an unheard-of thing, that Oxford should get a Regius Professor of Medicine from Baltimore: but it was a grand success. He drew together, in his profession, so far as one man could, America and England. He came at the end of the Augustan Age in Oxford: and it was like home to him.

There can be no higher praise of his influences—and it is not too high—than to say that he exercised, in medicine, that secret of teaching which Ruskin exercised in painting and architecture; and it is worthy of note that his writings have a touch, and more than a touch, of Ruskin, both in thought and in style. Only, life was kinder and sunnier to him: Ruskin is tragedy: Osler went from one happiness to another.

The new edition of Dr. Camac's anthology, "Counsels and Ideals," is good as good can be—full of wisdom, learning, humour, practicality, and loving-kindness. Not all of us, in the medical profession, can ever expect to rise from the ranks. For some of us, here and there in Osler's writings, the ideals must appear to be above attainment, and the counsels to be counsels of perfection. We have not, and we never shall have, his advantages. Yet, as one turns the pages, what a treasury of sound advice is in them! For example:—

(1) "Often the best part of your work will have nothing to do with potions and powders, but with the exercise of an influence of the strong upon the weak, of the righteous upon the wicked, of the wise upon the foolish. To you, as the trusted family counsellor, the father will come with his anxieties, the mother with her hidden grief, the daughter with her trials, and the son with his follies. Fully one-third of the work you do will be entered in other books than yours."

(2) "From the day you begin practice, never under any circumstances listen to a tale told to the detriment of a brother practitioner; and when any dispute or trouble does arise, go frankly, ere sunset, and talk the matter over, in which way you may gain a brother and a friend. . . . It is the confounded tales of patients that so often set us by the ears. . . . There is only one safe rule—never listen to a patient who begins with a story about the carelessness and inefficiency of Dr. Blank. Shut him or her up with a snap, knowing

full well that the same tale may be told of you a few months later."

(3) "Intemperance in the quantity of food taken is almost the rule. Adults eat far too much."

(4) "Things medical and gruesome have a singular attraction for many people. . . . To talk of diseases is a sort of Arabian night's entertainment to which no discreet nurse will lend her talents."

For graver and more intimate converse with Osler's mind, we have this anthology as our companion—a book worth reading, worth buying.

Our Bookshelf.

The Position in Space of the Aurora Polaris, from Observations made at the Haldde Observatory, 1913-14. By L. Vegard and O. Krogness. (Geofysiske Publicationer, vol. 1, No. 1.) Pp. vii + 172 + plates. (Kristiania: A. W. Brøggers Boktrykkeri A/S, 1920.)

THIS is an elaborate account of observations made to determine the height of the aurora, by the method originally devised by Störmer, and used by him in 1910. The method consists in photographing the aurora simultaneously at two stations some miles apart, and determining its parallactic shift relative to the stars. In the present work the authors employed a base line of 12·5 kilometres, much larger than the base of only 4·5 kilometres used by Störmer in his first experiments.

The lowest height of the aurora is a question of long-standing controversy. Many of the older observers thought that it reached on occasion to the ground level, but Dr. Simpson's observations in the Antarctic led him to think that this was an illusion, and certainly it seems very improbable if the theories now current of the origin of the aurora in corpuscular rays are to stand. Störmer never found anything lower than about 40 kilometres, and the present work seems to indicate that the lowest values found by him were erroneous, the base line employed not being long enough for accuracy. Vegard and Krogness find the lower limit to range from 73 to 166 kilometres. They find an indication of two maxima in the height distribution curve, at 100 and 106 kilometres respectively, and incline strongly to believe that these are real, and due to the presence of two kinds of corpuscular rays.

The methods of measurement and reduction are set out in great detail, and a large number of photographs are reproduced. R.

Dairy Bacteriology. By Prof. Orla-Jensen. Translated from the second Danish edition, with Additions and Revisions. By P. S. Arup. Pp. xii + 180. (London: J. and A. Churchill, 1921.) 18*s.* net.

THIS book has already passed through two editions in Denmark, and is now translated into English. It will be found to present a useful summary of the subject for the dairy worker, giving him information that will be of value in his routine work, and will help him in coping with the troubles that periodically arise in dealing with farm products.

Milk fresh from healthy cows contains a few organisms derived mainly from the air, the udder, and the teats; these are nearly all micro-cocci and sarcina forms, most of which are without action on the milk, though a few acidify and peptonise it. Milk which has been less carefully handled is liable to contain a great variety of organisms—coli, aerogenes, and others from the dung; fluorescent bacteria from the water used for rinsing the pails; and others from the bedding, stable dust, etc. The American "certified milk" contains less than 10,000 of these organisms per c.c.; this keeps well. The author gives other figures for other samples, running up to hundreds of millions per c.c. There is a good account of milk preservation and treatment.

Mitteilungen der Naturforschenden Gesellschaft in Bern aus dem Jahre 1919. Pp. lxxv + 231 + Tafel 5. (Bern: K. J. Wyss Erben, 1920.)

THE scientific communications published in this volume are mainly of local interest. Prof. Ed. Fischer chronicles additions to the list of species in the flora of Berne which have been noted in the past ten years; a large number are aliens which have been introduced in various ways. The most important communication in point of length is by Werner Lüdi on "The Succession of Plant Associations," an ecological study of the vegetation of the Bernese Oberland, with special reference to the Lauterbrunnen valley. Dr. R. Stäger describes some myrmecological observations on the Belalp at more than 2000 metres elevation, in which he notes the distribution of the seeds of *Thesium alpinum* by two species of ant. E. Gäumann gives an account of the occurrence and area of distribution in Switzerland of the species of the parasitic fungus genus Peronospora, and there is also a paper on the etiology of the "grippe" by Dr. Sahli.

The Elements of Direct-current Electrical Engineering. By H. F. Trewman and G. E. Condliffe. Pp. vii + 219. (London: Sir Isaac Pitman and Sons, Ltd., 1921.) 7*s.* 6*d.* net.

THE object of this addition to the many electrical text-books is to bridge the gap between elementary handbooks and treatises on dynamo design. The general principles of induced currents and electromagnetism are briefly recapitulated, a few of the more common instruments are described, and the main features of the direct-current dynamo and motor are treated in a practical way. We are pleased that the authors have the courage to use the calculus in such an elementary work where it simplifies proofs, for, as they rightly point out, "it is essential to all students of engineering." The treatment is apt to be a little too sketchy for the second-year student for whom the work is intended, and future editions should remove such blemishes as "electric-motive force."

Letters to the Editor.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

Relativity and Materialism.

PROF. WILDON CARR has for a number of years been busily engaged in ringing the death-knell of materialism. I was therefore not a little surprised to read in NATURE (October 20) his statement that Einstein's theory was the "death-knell of materialism." I thought, from my previous acquaintance with Prof. Carr's writings, that Bergson, Croce, and others had already done all that was necessary in that direction. But no! Prof. Carr has resuscitated it for the express purpose of killing it once more. That unfortunate doctrine seems to exist mainly for the purpose of being periodically slaughtered by professors of metaphysics; and we are led to the conviction that materialism must have very singular properties to survive so many tragic executions.

Well, it does possess a property which must naturally appear singular to those steeped in metaphysics—it happens to be true. Scientific materialism, as now understood, does not profess to be a rounded or final system of philosophy: it is merely a name for a few general principles, laid down by science, and selected for emphasis on account of their high human significance. Science makes new knowledge; philosophy (rightly understood) does not; it simply collects together certain principles yielded by science, those principles being selected as having some bearing on the deep undying problems of most profound human interest.

Among the scientific principles thus selected and emphasised by materialism—and the only one among them still seriously controverted—is that which states that mind cannot exist apart from matter, or as I prefer to put it, that mind is a function of material organisms. Prof. Wildon Carr is of opinion that mind *can* and *does* exist apart from matter; and he is under the impression that this opinion is justified by the principle of relativity. So far as I can follow his argument, it amounts to this. Space and time are relative to the observer; therefore the existence of an observing mind must be antecedent to the existence of space and time. True; but space and time are not matter: they are not objective things; you cannot weigh them or touch them; they are part of the mental framework which we erect for our convenience in dealing with external nature. They are concepts; just as the number 10 is a concept; not a thing, but a framework into which things can be fitted. "For the concept of relative space-time systems the existence of mind is essential." Prof. Carr might with equal profundity have said that for the presence of dew the existence of water is essential. Dew is aqueous; a concept is mental; but let me inform Prof. Carr that neither one nor the other of these propositions gives the slightest qualm to any scientific materialist, nor have they the least relevance to the question whether or not mind depends upon matter. We are not concerned with "concepts," which, of course, imply the previous existence of mind, but with objective *things*.

Now Prof. Carr argues that the "space-time system," involved by relativity, is conditional on the existence of mind. Very well then. It follows that if mind were to be extinguished throughout the universe, the laws at present ascribed to the universe would cease to operate, or perhaps the universe itself would cease to exist. Now that is an altogether incredible proposition. If Prof. Carr's mind were to be extinguished, the laws of nature would still remain as they are. If everybody else's mind were also to be extinguished, the laws of nature would be unaltered. "Concepts" would vanish no doubt; but the validity of the principle of relativity itself does not depend on the existence of a mind which can testify to it. Prof. Carr exhibits that incurable confusion between concepts and objects which is common to all those who think that metaphysics is a rival method of science in the making of new knowledge.

Relativity of space and time no more conflicts with scientific materialism than does relativity of motion. But it is idle to argue with sentiment, and it is with sentiment alone that we have to do—sentiment unsupported by a fragment of evidence, and asserting itself in flat contradiction to every principle of logic. As a mere statement of truth, materialism will always reign, as it has reigned now for centuries as the basis of scientific experiment. But on a show of hands it will always be in a minority; its reign is that of an uncrowned king. There exists a wide and universal human sentiment which loathes materialism. That sentiment comes out in many different forms: in the vulgar superstitions of the uneducated, in spiritualism, in metaphysical dissertation. They are but the same deep sentiment on different intellectual grades, but as false and rotten in the higher grades as they are in the lower. Everywhere it comes out: in physiology we find it as vitalism; among the public at large it supports religion, the most powerful single factor that has moulded the destinies of civilised humanity. Materialism must always be unpopular; that is why it is so often being killed. But it is true; that is why it never dies; that is why it never will die; unless, indeed, it is one day drowned in the floods of oily sentimentalism.

Two hundred and fifty years ago the world of physics was fermenting as it is now. Newton was introducing a revolution of thought, comparable to the revolution of the last twenty years. Then, as now, the sudden upsetting of old ideas had in some sense a demoralising effect. There seems a real danger that metaphysics may take root, for a brief period, amid the general disorganisation consequent upon the revolution. A spectator does sometimes see most of the game, and I trust it may not be considered presumptuous in a spectator to sound an old note of warning at a time when many insidious invasions of science are being attempted by metaphysics: "Physics, beware of Metaphysics."

November 18. HUGH ELLIOT.

Metallic Colouring of Beetles.

IN reference to Mr. Onslow's letter on this subject in NATURE of November 17, I may say that it requires some care to prepare specimens for the pressure test. The chitinous coat is thick, and is softer below than it is at the colour-producing surface. The inner layers should be removed so far as possible, and the test-piece (which should not exceed 1/50 in. in diameter) cut from the remaining part.

In my experience, when these conditions are attended to the colour vanishes under pressure, and

in many cases returns when the pressure is relieved. The appearance then suggests a lamp alternately extinguished and relit.

The same precautions as to the smallness of the test-pieces and the absence of a comparatively soft bed under the coloured layer have to be observed in the case of metallic feathers.

The colours of anilin films are not affected by pressure otherwise than by the optical contact between them and the upper quartz lens.

The same may be said of the colours of tempered steel, etc. A simple experiment is to heat a piece of polished steel and to remove by polishing a narrow band of the coloured part. Then form a series of Newton's rings, having this band as a diameter. It will be found that in the straw-yellow of the tempered part the rings are scarcely displaced as they cross the band. Further, it may be noticed that when any of the colours are gradually polished off the colour does not change as the thickness of the layer is reduced but merely becomes fainter.

From this it may be gathered that the colours of tempering are not due to interference, at any rate in the ordinary sense in which the word is used.

A. MALLOCK.

The Tendency of Elongated Bodies to Set in the North and South Direction.

THE letters of Sir Arthur Schuster and Col. E. H. Grove-Hills in NATURE of October 20 and November 24 under the above heading are interesting, as is also the article by Mr. W. D. Lambert in the *American Journal of Science* for September last, to which reference is made by the latter, but the extremely weak gravitational force dealt with cannot possibly have any appreciable effect on my apparatus, and is certainly quite inadequate to account for the results of experiments made with it. Indeed, I gather from some of Sir Arthur Schuster's remarks that he feels that this is the case. The force that I have found to exist is another altogether, as I am confident anyone who has watched the experiments under favourable conditions would admit.

Mr. Lambert in his article is referring to a suspended rod of 40 cm. length, weighted at both ends, and finds for this that the force was only 1/400,000th of a dyne or 1/400,000,000th of a gram. Now, what conceivable effect can such a force have on a vertically suspended circular ring or disc of the thinnest paper, or other light material, of only 3½ cm. diameter? And yet it is with these that some of the most decisive results of my experiments have been obtained. Under favourable conditions the N. and S. directive force acting on the disc is by no means insignificant, and, indeed, when the sky is clear, the barometer high and steady, and there is no wind, it is frequently strong enough, when the apparatus is placed on high level ground in the open, to cause the disc to come to rest in the true N. and S. direction in less than five minutes, or to oscillate fairly rapidly (about five seconds interval) a few degrees on either side of this line. Moreover, other conditions are inconsistent with any purely gravitational theory being the explanation. I have used both suspended discs and pointers floating on paraffin oil, and obtained about the same results from both; not that one gives the E. and W. direction and the other the N. and S. The only difference noticed was that the floating pointer took longer to come to the N. and S. line. Further, it is not necessarily the elongated diameter that turns N. and S., as Sir Arthur Schuster assumes. For instance, if a strip of aluminium about 1 in. wide is coiled round into the form of a ring and then flattened so that the sides almost touch each other, when suspended vertically the flat-surface sides turn N. and S., as in the case of the ordinary discs. Now, if these flat surfaces are pulled out so as to form a ring with the elongated horizontal diameter several times as long as the breadth of the strip, it is not this elongated diameter that turns N. and S., but the surface breadth of the strip as before. In fact, there is no alteration in the direction, but the surface sides of the aluminium strip take up the same direction as when they were flattened close together.

In rainy weather, or when the sky is clouded or the barometer is falling, no satisfactory results can be obtained, and the disc will then usually turn approximately towards the bearing of the thickest clouds. From repeated experiments it has been found that when the apparatus is placed in an iron bucket covered with an iron lid, the N. and S. directive force ceases to act upon the disc, although it may be fairly strong in the open at the same time. The force appears to be strongest in still, frosty weather, when the sky is clear, even though there may be some ground mist.

Since the apparatus was exhibited at the Royal Society's conversazione in May of last year many more experiments have been made by observers in different parts of the world, extending from Spitsbergen in latitude 80° N. to the top of the Cameroon Mountain (13,353 ft.) close to the equator, and from Canada and the United States to the Red Sea, all of which give much the same results that I and others have obtained in this country; so whatever may happen in other parts, there can be no doubt that over this wide area of the earth's surface this N. and S. directive force does exist. In one or two other cases the results have been indefinite, owing apparently to the observers having no proper apparatus or the weather conditions being unfavourable. It is perhaps too early yet to speak positively about the nature of this N. and S. directive force, but the conclusion I have come to is that, in the main, it must be electric, and is probably due to the earth rotating in an electric field.

E. A. REEVES.

Roval Geographical Society,
Kensington Gore, S.W.

Table for the Duration of Sunset.

THE subioined table was made thus:—From Table VI. in the American Nautical Almanac, for each date and latitude indicated, the hour of sunset on the meridian of Greenwich is taken and corrected for equation of time, giving an hour-angle precise within 1m. or 15′ (as both local mean time and equation of time are rounded off to the nearest minute). From latitude, declination, and this hour-angle the semi-duration of sunset in arc minutes is computed by the differential formula,

$$(1)\quad dP_1 = \cos h\ dh / \cos\phi \cos\delta \sin P_1,$$

in which P_1 = hour-angle, h = altitude of sun's centre, ϕ = latitude, δ = declination, and dh = sun's semi-diameter. As the hour-angle found from the Nautical Almanac is for the end of sunset, it is corrected by subtracting this approximate semi-duration, and the final value in mean time seconds is found by

$$(2)\quad dP = 8 \cos h\ dh / \cos\phi \cos\delta \sin P,$$

in which all sines and cosines refer to mid-sunset,

declination and equation of time being constant within 1/10° or 1m.

For computing a very good 10-in. slide-rule was used, which gives results as good as the Almanac hour-angles will allow and good enough for rough comparison with observed durations. (In careful study of the effects of atmospheric changes on sunset duration one would compute each sunset separately, with exact hour-angles, formula (2), and four-place logarithms.) In copying, the slide-rule results are rounded off to whole seconds.

In a most unfavourable case, winter solstice and latitude N. 60°, 1921, assuming the data of Table VI., American Nautical Almanac (given on p. 156, 1922), the error of computing may be tested. Computing the hour-angles for the beginning and end of sunset by the sine formula for time sights with declination and equation of time for the moments, and six-place logarithms, they are 42° 15′ 16·4″ and 43° 59′ 14·4″; the local mean times corresponding are 2h. 47m. 37·0s. and 2h. 54m. 33·0s.; the duration of sunset is 6m. 56·0s. = 416·0s.

The mean hour-angle is 43° 7′ 15·0″. Using this in the differential formula (2), four-place logarithms give 415·5+ s., slide-rule 415·0+ s.; so that the differential formula is in error by less than ½s., or less than $\frac{1}{8}$ per cent.

By slide-rule computing the differential formula with the hour of Table VI., 2h. 54m., the hour-angle at end is 43° 45′, first approximate semi-duration 51·3′, final mid-sunset hour-angle 42° 53′+, final computed duration 417·5s. This is an error of 1·5s. The result for the corresponding date of 1922, given in the table following, 414s., differs on account of a slight difference in the equation of time.

For lower latitudes the error grows smaller, as sin P approaches 1 and becomes insensitive; *e.g.* for the same date in 1921 and N. 45° six-place logarithms give 221·5s., four-place 221·7+ s., and slide-rule 221·5s.

For latitudes and dates intermediate among those of the table, and for other longitudes, linear interpolation suffices about as well as it does for the hour of sunset in Table VI., except that the date intervals are much longer; sunrise durations may also be interpolated. While the dates are for 1922, the values given should be good, within their limits of error, in other years as well.

Examination of the table, or of a graph of the same, shows that during the year for any latitude there are two maxima about the solstices and two minima about the equinoxes. The maxima are sharper than the minima. In low latitudes the summer maximum is less than the winter, due to the smaller semi-diameter of the sun; but in high latitudes, beginning above N. 52°, this is reversed, due to the unsymmetrical and exaggerated effect of refraction, which makes the sines of summer solstice hour-angles less than those of the winter solstice. At the autumnal equinox the duration is somewhat less than at the vernal, due to less semi-diameter; this holds good for all latitudes where the term "sunset" has any meaning. Elevation above sea-level would have an effect like refraction.

Since even constant refraction may thus reverse the effects of changing semi-diameter, it is clear that varying refraction must have considerable effect on the duration of sunset. In studying this effect, which led to the construction of the table, it is best to obtain the hour-angle directly with a watch; for when the time-sight formula is used an assumption has to be made about refraction, and an error in this assumption may considerably affect the hour-angle and so the computed duration. Between the tropics this error is of less account than in higher latitudes, but it is eliminated by the use of a watch.

The Duration of Sunset (in Seconds), 1922.

Lat. N.		0°	10°	20°	30°	35°	40°	45°	50°	52°	54°	56°	58°	60°
Jan.	1	142	144	152	168	180	197	220	253	270	292	319	356	406
,,	15	140	142	150	165	177	192	213	243	258	277	300	328	367
Feb.	1	136	138	146	160	170	184	203	226	239	254	271	292	318
,,	15	133	135	142	155	164	176	193	214	225	237	251	267	287
Mar.	1	131	133	139	152	160	171	186	205	215	225	237	251	267
,,	15	129	131	137	149	157	168	182	201	209	219	231	243	258
April	1	129	131	137	149	158	169	182	202	210	221	232	245	261
,,	15	130	132	138	150	159	171	186	207	216	228	241	255	273
May	1	132	134	141	154	164	177	192	217	229	243	258	278	300
,,	15	134	136	144	158	169	183	203	230	244	261	281	306	338
June	1	136	139	146	163	174	192	212	244	262	283	309	345	394
,,	15	138	140	148	164	178	194	218	252	272	295	327	368	429
July	1	137	140	148	164	176	193	216	251	269	292	322	364	422
,,	15	136	138	145	161	173	188	209	242	258	278	304	337	383
Aug.	1	133	136	143	156	168	181	201	227	239	256	275	298	329
,,	15	131	133	140	153	162	175	191	214	226	238	254	272	294
Sept.	1	128	131	137	149	158	170	184	204	213	224	237	251	268
,,	15	128	130	136	148	156	167	181	199	208	218	229	242	257
Oct.	1	128	131	137	148	157	168	182	200	208	218	229	242	257
,,	15	130	132	139	151	159	171	186	205	214	225	237	251	267
Nov.	1	134	136	143	156	164	178	195	217	228	241	256	274	295
,,	15	137	139	146	159	171	185	204	230	243	259	277	300	329
Dec.	1	140	143	150	166	177	193	214	245	261	281	305	336	376
,,	15	142	144	152	168	181	197	220	254	271	293	322	359	411
Mar.	21	129	131	137	149	157	168	182	200	209	219	230	243	257
June	21	138	140	148	164	177	194	217	253	273	297	328	370	434
Sept.	23	128	130	136	148	156	167	181	199	207	217	229	241	254
Dec.	22	142	145	153	169	181	198	222	255	273	295	324	362	414

WILLARD J. FISHER.

49 Langdon Street, Cambridge, Mass.,
October 23.

Relativity: Particles Starting with the Velocity of Light.

I WISH to point out a peculiar property of the motion of a particle in the theory of relativity when the initial speed is that of light. The result is valid for both the special and the general theory of relativity, but for simplicity I shall consider here only the former case. We start, then, with the Minkowski formula, $ds^2 = c^2dt^2 - dx^2 - dy^2 - dz^2$ This vanishes for the motion of a light-pulse. The interval ds is imaginary when the velocity is greater than that of light, and is real when the velocity is less than that of light.

If the velocity v of the particle is always equal to c, then all the elementary intervals vanish, so that the length-interval between any two positions is always zero. If, however, the particle merely starts out with the velocity of light and then slows down, so that the acceleration is negative, the interval between the initial world-point P and any other world-point Q will not be zero, and we raise the following question: What is the ratio between the arc PQ and the chord PQ, or, rather, what is the limit of this ratio as Q approaches P? Here, of course, we mean that both arc and chord are measured by means of the interval formula. If we use ordinary Euclidean measurement, of course the limit of this ratio for real curves is always unity. For the Minkowski geometry it turns out that the limit is unity whenever the initial velocity is less than the velocity of light, but in the exceptional case we are now considering we find that the limit is actually different from unity, and, in spite of ordinary intuition, is actually less than unity.

Our precise theorem is as follows:—*If the initial velocity is that of light and the initial acceleration is not zero, then the limit of the arc to the chord is* $\frac{2}{3}\sqrt{2}$, *which is approximately* 0·94.

If the initial acceleration is zero, so that the velocity remains that of light for neighbouring points, then the limit may have any value.

That the limit of the arc to the chord is not always unity for curves in the Euclidean plane was first

pointed out by the present writer (Bulletin of the American Mathematical Society, vol. 20, 1914, pp. 524–31), but the exceptions there are all imaginary, for the slope of the curve at the initial point has to be equal to $\sqrt{-1}$. The result is that the limit then takes a discrete set of values. It has to be one of the numbers 0·94, 0·86, 0·80, 0·74, . . . ; the particular one depending on the contact of the curve with the minimal straight line at the given point. If there is no contact the value is unity, but if the contact is of order $k-1$, then the value is $\frac{2\sqrt{k}}{k+1}$.

For Euclidean space of three dimensions it comes out that the limit can take all real and complex values. The Minkowski space is four-dimensional, and here also continuous variation is possible; but the essential point is that on account of the *minus* signs in the interval formula the exceptional cases which were imaginary in the Euclidean geometry now become physically real. This does not mean, however, that experimental verification would be easy. Particles have been found in radio-emanations where the initial velocity is more than nine-tenths that of light, but as long as the velocity is actually less than that of light the limit we are dealing with is unity. As the velocity is increased the limit thus remains unity. It takes the exceptional value 0·94 only when the initial velocity is actually that of light. Therefore, as the initial speed is increased continuously up to c, the limit jumps suddenly from unity to 0·94. The limit of the limit equals 1, but the actual value attained equals 0·94. *Such a discontinuity is perhaps beyond the possibility of experimentation, but there is no doubt of its theoretical validity.*

If, instead of the Minkowski formula, we use the general Einstein relativity theory, we have a curved manifold of four dimensions instead of a flat manifold. The formulæ, involving the potentials g_{ij}, are much more complicated, but again we find exceptional values for the limit of the ratio of the arc to the chord whenever the initial velocity is that of light—that is, whenever the world-line is tangent to a null geodesic on the curved manifold representing the field of gravitation.

EDWARD KASNER.

Columbia University, New York, September 20.

The Softening of Secondary X-rays.

DR. A. H. COMPTON'S letter to NATURE of November 17, p. 366, on the softening of secondary X-rays directs further attention to a problem of very great importance. There is distinct evidence with these rays of a change of periodicity which varies with the angle of scattering. Such a variation is, perhaps, unique in physics, and no satisfactory explanation of the facts has been found. Let us consider the history of the case.

In 1913 (*Phil. Mag.*, vol. 26, p. 611) I stated that when homogeneous rays struck any target the scattered rays were softer (*i.e.* of lower frequency), and that this softening increased with the angle of scattering. This view was a deduction from experiments with a heterogeneous primary beam consisting of the γ-rays of radium. The experimental results were verified by Dr. Florance (*Phil. Mag.*, vol. 27, p. 225, 1914).

In 1919, working at University College with heterogeneous X-rays, I again found that the secondary rays were less penetrating than the primary. At the time I was not successful in obtaining a homogeneous primary beam of sufficient intensity, for such a beam can be obtained only by reflection from a crystal. Later on I was informed that Mr. S. J. Plimpton, on continuing the problem at University College, had found evidence which apparently showed that when the primary rays were homogeneous, the secondary rays were of the same frequency. Hence, in a paper to the Journal of the Franklin Institute (November, 1920), I endeavoured to account for the softening observed with heterogeneous X-rays by assuming them to consist of thin pulses, which became thicker and softer, and hence of smaller apparent frequency as the scattering angle increased. Plimpton published his results in the *Philosophical Magazine* for September, 1921.

The work of Compton (*Phil. Mag.*, vol. 41, p. 749, 1921, and *Phys. Rev.*, vol. 18, p. 96, 1921), however, confirms my original view, although it may perhaps be advisable to substitute the term "secondary rays" for "scattered rays." On working with homogeneous X-ray beams he finds the same change as when ordinary X-rays of corresponding penetrating power are used. Thus secondary X- or γ-rays, even when homogeneous, decrease in frequency as the angle of scattering increases, and this remarkable relation is independent of the scattering medium.

I have always looked on the secondary rays as scattered rays, because the theory of scattering first given by Sir Joseph Thomson ("Conduction of Electricity through Gases," 1906, p. 321), and since developed by other writers, accounts so well for the variation in intensity of the secondary radiation with angle of scattering, and also for the observed polarisation of the secondary radiation. This theory, however, in its present form does not account for the changes in periodicity referred to above.

Compton suggests that the greater part of the secondary radiation is fluorescent, *i.e.* that it is produced by the secondary β-rays which are always emitted when X- or γ-rays strike any substance, and that the change in periodicity can be accounted for by means of the Doppler principle. I believe that it can be proved that only a negligible portion of the secondary X-rays can be accounted for in this way, and hence that this suggestion does not help us out of our difficulties.

J. A. GRAY.

McGill University, Montreal, November 12.

University Relief for Central Europe and Russia.

I SHALL be grateful for space to bring before readers of NATURE the following facts concerning the activities of the Imperial War Relief Fund, Universities' Committee. This committee, which was created at an Inter-University Conference which met at University College, London, on July 7, 1920, at the invitation of Lord Robert Cecil, and under the auspices of the Imperial War Relief Fund, has set before it the aim of presenting to the British universities the appeal of the universities in the war-stricken areas of Europe.

During the first year of the existence of the Universities' Committee 32,000*l.* was raised in co-operation with every university in Great Britain and Ireland. The committee at the opening of this university year carefully considered the problem of the Central European universities at the present time, and decided that it would be absolutely necessary for us to maintain the relief work promoted by the committee in co-operation with universities all over the world throughout the coming year.

I may say briefly that the financial panic which has swept through Austria in particular during the

last month has threatened the very existence of many distinguished men in universities of that country.

The Universities' Committee has also taken on the further responsibility of endeavouring to raise funds for the relief of men of learning and students in Russia. In careful consultation with Dr. Nansen, the committee is establishing those links in Russia which shall ensure a wise distribution of the funds subscribed. Dr. Nansen has issued a personal appeal to the universities of the world to help to save from extinction the rapidly diminishing numbers of men in Russia who have been able to go through the ordeal of suffering to which many of them have been subjected during the past few years. May I appeal to readers of NATURE for their support of the work of the Universities' Committee?

Further detailed information, which for lack of space cannot be given here, Miss Iredale, the organising secretary, will always be glad to send on application to any reader.

In a letter to graduate members of the British universities on behalf of the men of learning of Austria an urgent appeal has been made over the following signatures of distinguished representatives of learning:—

William Bragg,	Gilbert Murray,
Bryce,	E. Rutherford,
A. S. Eddington,	M. E. Sadler,
Richard Gregory,	Arthur Schuster,
Haldane of Cloan,	Napier Shaw,
Frederic G. Kenyon,	A. E. Shipley,
Walter Lock,	George Adam Smith,
Donald Macalister,	Ernest H. Starling,
Charles J. Martin,	J. J. Thomson.
Henry A. Miers,	

MAURICE DE BUNSEN,
Chairman, Universities' Committee.
Fishmongers' Hall, London Bridge, E.C.4,
November 21.

Ophion luteus.

I BEG to thank Dr. Gahan and Dr. Stenton for their notes on this insect in NATURE of November 24, p. 403. I am well aware of the importance of precision in recording the behaviour of any animal and any other natural phenomenon; wherefore I was specially careful to ascertain from the persons who had been stung by Ophion in my house whether the insects had received any provocation. In most of the cases brought to my notice (numbering three or four in each of the last five years) the person stung was asleep, and may semi-consciously have made some movement that irritated the fly. But in the case I mentioned as happening last August, the young lady was reading in bed and felt the sharp stab on her arm before she saw the fly.

Our experience of the results of the sting differs from that of M. R. du Buysson as quoted by Dr. Gahan; but, of course, individuals differ very much in susceptibility to poisonous stings. The persons stung in my house, so far as has been brought to my notice, were all young, except one lady more than forty years of age. In her case, as in the others, the sting was followed by a painful and peculiarly hard swelling which did not subside in less than twenty-four hours.

Dr. Stenton asks whether care was taken to identify the species of Ophion. I sent specimens for identification to both Dr. Gahan and Mr. J. M. Gordon, who concurred independently in pronouncing the fly to be *Ophion luteus*.

HERBERT MAXWELL.
Monreith, Whauphill, Wigtownshire, N.B.

The "Zoological Record."

THE *Zoological Record*, which was founded in 1864 by English zoologists, has been issued regularly ever since, and contains each year a complete bibliography of all publications connected with zoology. It is now the sole work of the kind, and is invaluable to all workers in every branch of zoology.

Previous to 1914 the *Zoological Record* formed part of the "International Catalogue of Scientific Literature," and was issued under the joint responsibility of the Royal Society and the Zoological Society. As the Royal Society found itself unable to proceed with the volumes of the "International Catalogue" after the issue for 1914, the Zoological Society has undertaken to prepare and issue the volumes for 1915–20 inclusive at its sole financial risk.

It is the wish of the Record Committee of the Zoological Society to continue the publication of this most useful work, but it is obvious that it cannot expect the society to undertake the heavy financial liability involved in publication, unless it receives reasonable support from working zoologists both at home and abroad.

I hope, therefore, that all working zoologists who agree with me that the suspension of the publication of the *Record* would have a most disastrous effect on the progress of zoology will either subscribe themselves, or will urge the librarians of the institutions with which they are connected to do so.

A prospectus and form of subscription either for the whole or separate divisions of the *Record* can be had on application to the Zoological Society.

W. L. SCLATER,
Editor, *Zoological Record*.
Zoological Society of London, London, N.W.8.

Reflection from Cylindrical Surfaces.

THE cone of light reflected from a cylindrical surface described by Mr. Shaxby in NATURE of November 17, p. 369, is discussed in Tait's elementary treatise on Light.

A related phenomenon, also mentioned in the same work, the explanation of which is readily deducible from the above, is of interest. I refer to the circle of light seen by reflection of a distant point source from a bundle of cylindrical surfaces. The surfaces may be of any form, the condition being that their generating lines must all be parallel to one another. The locus of points of reflection is then a conical surface containing the source, with its apex at the eye of the observer. The axis of the cone is parallel to the generating lines of the surfaces. When the line joining the eye to the source is parallel to these lines, the circle reduces to a point coinciding with the source; when at right angles, the circle becomes a great circle passing through the source.

An everyday illustration of this is to be seen in the reflection of a distant street-lamp by the closed roller shutters of a shop-window. The points of light reflected from the corrugations form an arc of a circle which if completed would pass through the lamp.

The circle of light seen when viewing a point source through certain crystals is evidently due to the same phenomenon, the crystals presumably being fibrous in structure or containing enclosures or cavities with cylindrical surfaces. Some years ago Prof. S. P. Thompson submitted some crystals having this property to a meeting of the Physical Society of London.

C. O. BARTRUM.
32 Willoughby Road, Hampstead,
November 22.

Science in Westminster Abbey.

By ENG.-COM. EDGAR C. SMITH, O.B.E., R.N.

THE ceremony of unveiling a memorial in Westminster Abbey to the memory of the late Lord Rayleigh, which was held yesterday, November 30, may perhaps lend interest to a short account of the memorials to men of science already there. These memorials are more numerous than is generally supposed. There are few branches of science unrepresented, and in some directions the scientific activity of the nation is faithfully reflected by the men either buried or commemorated within the Abbey walls. Though interments have taken place in the Abbey for many centuries, it is only within the last two hundred years or so that any man of science has been buried there. The earliest British representative of science commemorated is the young astronomer, Jeremiah Horrocks, who died in 1641, a year or two after he had watched the transit of Venus. Astronomy is further represented by Adams and Sir John Herschel, but it is rather surprising that none of the Astronomers Royal—Flamsteed, Halley, Bradley, Maskelyne, or Airy—is commemorated. Mathematics and physics can show memorials to Barrow, Newton, Spottiswoode, Thomas Young, Joule, Stokes, and Kelvin; geology is represented by Woodward, Buckland, and Lyell; chemistry by Sir Humphry Davy; while Darwin, Wallace, and Hooker are the three outstanding naturalists. Surgery, medicine, and engineering all have memorials of interest, and to some of these brief reference will be made.

The first man of science of note to be buried in the Abbey was Sir Robert Moray, who played a very important part in the foundation of the Royal Society, and held the office of president up to the time of its incorporation. His grave is in the south transept. In his younger days an officer in the French army, Moray was royalist to the core, and received his knighthood from Charles I. He was also a favourite with Charles II., and though it is said that he "had no stomach for public employment," he served his Sovereign in various capacities. Of him Wood said that he was "a renowned chymist, a great patron of the Rosicrucians, and an excellent mathematician," while Burnet pronounced him "the wisest and worthiest man of the age." Moray is among the first of many fellows of the Royal Society commemorated in the Abbey, and the first of several presidents buried there. It was he who proposed Hooke as curator to the society. He died suddenly, July 4, 1673, in his pavilion in the gardens of Whitehall, and his funeral was carried out at the expense of Charles II.

Two years later the Abbey witnessed the interment of Thomas Willis, who as a young bachelor of medicine at Oxford had taken part in the meetings of the philosophers at the lodgings of Wilkins, Petty, and Boyle. Like Moray, a staunch royalist, at the Restoration he was made Sedleian professor of natural philosophy in the place of the ejected Joshua Crofts. Afterwards he gained much celebrity as a London doctor, his fame being such that it was said "that never any physician before went before him or got more money yearly than he." His death took place in his house in St. Martin's Lane, November 11, 1675, and a week later he was buried beside his wife in the Abbey, "an honour which he well deserved on account of his anatomy of the brain and the discovery of saccharine diabetes." The cost of his funeral is given at 470*l.*

In 1677 the Abbey saw the burial of Isaac Barrow, the celebrated mathematician and divine. First to hold the Lucasian chair of mathematics at Cambridge, Barrow in 1669 had resigned in favour of his pupil, Newton, and during the last three years of his life was master of Trinity. He died on May 4, and was buried not far from Moray in the north transept—now known as Poets' Corner. "He had come," says Stanley, "as master after master had come, to the election of Westminster scholars, and was lodged in one of the canonical houses 'that had a little stair to it out of the cloisters' which made him call it 'a man's nest.' He was there struck with high fever and died from the opium which, by a custom contracted when at Constantinople, he administered to himself." Another account says he died "in a mean lodging at a saddler's near Charing Cross." Moray, Wallis, and Barrow appear to be the only men of science buried in the Abbey during the seventeenth century.

The majority of the graves and monuments to men of science are found in the nave and the north aisle. Best known of all is the monument to Newton in the screen of the choir. Of the long inscription upon it Johnson said: "Had only the name of Sir Isaac Newton been subjoined to the design upon the monument instead of a long detail of his discoveries, which no philosopher can want, and which none but a philosopher can understand, those by whose direction it was raised had done more honour both to him and themselves." The gravestone close by bears the words: "Hic dispositum est quod mortale fuit Isaaci Newtoni." Voltaire was at Newton's funeral, and afterwards wrote: "Newton was honoured as he deserved to be both in his lifetime and after his death. The chief men of the nation contended for the honour of bearing the pall at his funeral. Go into Westminster Abbey; admiration is not paid to the tombs of the kings, but to the monuments which the gratitude of the nation has erected to the greatest men who have contributed to its glory. Their statues are to be seen there like those of the Sophocles and the Platos at Athens, and I am convinced that the mere sight of these glorious monuments has stimulated more than one spirit, and has formed

more than one great man." It is from Voltaire we have the story of Newton and the apple. He was in England from 1726 to 1729, and he learned it from Newton's niece, Mrs. Conduitt.

Buried next to Newton is his great successor, Lord Kelvin, while a little farther towards the centre of the nave are the graves of Telford and Robert Stephenson. Thomas Telford, designer of the suspension bridge over the Menai Straits, engineer of the Caledonian Canal, first president of the Institution of Civil Engineers, "a fellow of infinite humour and of strong, enterprising mind," died at 24 Abingdon Street, Westminster, on September 2, 1834, and was buried in the Abbey on September 10. Twenty-five years later Robert Stephenson, at his own request, was buried beside him. Both are commemorated elsewhere in the Abbey, Telford by a statue, Stephenson by a window. Still nearer the centre of the nave, and not far from the spot hallowed to-day as the resting-place of the "Unknown Warrior," is the common grave of Thomas Tompion (1639–1713), "the father of English watch-making," and his successor, "honest George Graham" (1673–1751), who constructed astronomical instruments for Halley and Bradley, and "whose inventions do honour to ye British Genius, whose accurate performances are ye standard of mechanic skill." The present tombstone was removed in 1838, and for some years, until Dean Stanley replaced it, Graham's grave was marked only by a plain lozenge-shaped stone. At the west end of the nave is the memorial to John Conduitt (1688–1737), who married Newton's niece and succeeded him at the Mint. It is within Conduitt's monument that a tablet was placed some forty years ago to commemorate the brilliant work of the young Lancashire clergyman, Jeremiah Horrocks.

Of no less interest than the nave is the north aisle, the windows of which commemorate the work of Richard Trevithick (1771–1833), most fertile of inventors, and, like Hedley, Blenkinsop, and George Stephenson, one of the fathers of the locomotive; the younger Brunel (1806–59), who lived just long enough to see the completion of his greatest works, the Albert Bridge at Saltash, and the "Great Eastern"; Sir Benjamin Baker (1840–1907), joint engineer with Fowler of the Forth Bridge; Joseph Locke (1805–60), one of the greatest of railway engineers; Robert Stephenson (1803–59), constructor of the London to Birmingham railway, designer of many famous bridges, and, like Baker and Locke, president of the Institution of Civil Engineers; Lord Kelvin (1824–1907), the greatest of modern physicists, who redeemed the Atlantic cable from failure and showed the possibility of utilising the power of Niagara; and Sir William Siemens (1823–83), electrician and metallurgist, a pioneer of the dynamo, and the inventor of the regenerative furnace, and president of the Institution of Mechanical Engineers.

Beneath these windows are the monuments to John Woodward (1665–1728), professor of physic at Gresham College, founder of the chair of geology at Cambridge, and author of an "Essay towards a Natural History of the Earth"; the grave of, and monument to, Sir Charles Lyell (1797–1875), "the founder of English geology"; and near the spot where Ben Jonson was buried upright in a space 2 ft. by 2 ft.—all he asked for—is the grave of John Hunter (1728–93), the great anatomist. Originally buried in the vaults of St. Martin's-in-the-Fields, Hunter's coffin was brought to light by Frank Buckland as the result of a unique example of "chivalrous devotion to the relic of a great man." At the close of the afternoon service in the Abbey on March 28, 1859, in the presence of the president and fellows of the Royal College of Surgeons, Hunter's remains were re-interred among those of his peers. A little past the monument to Richard Mead (1673–1754), "prince of English physicians," who attended Newton in his last illness, and with whom Woodward fought a duel in the entrance to Gresham College, are found the graves of Darwin and of Sir John Herschel, "the prose poet of science," whose vow "to try and leave the world wiser than he found it" was amply fulfilled by a life full of the noblest effort.

Further to the east, just within the aisle of the choir, and grouped about the tomb of Lord John Thynne, fifty years a canon of Westminster, are the memorials to Adams, Stokes, Hooker, Wallace, Darwin, Lister, and Joule. Most of these memorials are portrait medallions, but that to Joule is a tablet, the inscription upon which states that it was erected "in recognition of services rendered to science in establishing the law of the conservation of energy and determining the mechanical equivalent of heat," achievements which, in the words of Tyndall at the Jubilee of 1887, formed "the largest flower in the garland which the science of the last fifty years is able to offer to the Queen." Mention must also be made of the statue close by of Sir Stamford Raffles (1781–1826), founder of the colony of Singapore and the first president of the Zoological Society.

Standing at the angle of the choir—now known as Science Corner—close to the grave of Darwin, with the graves of Newton and Kelvin to the south and the windows to the engineers to the north, in full view of the memorials of Darwin, Stokes, and Lister, it may be questioned whether there exists another spot which recalls such high endeavours, such lofty aims, such devotion to the search for truth and the spread of knowledge. The Abbey here is a veritable temple of science rivalling in interest the Statesmen's Aisle, the tombs of Plantagenets and Tudors, and even the Poets' Corner. Here are commemorated those whose guiding star was: "Prove all things; hold fast to that which is good." Here indeed are some to whom apply the words: "A wise man shall inherit glory among his people, and his name shall be perpetual."

The south aisle contains four monuments of scientific interest, the men commemorated being

Martin Folkes (1690–1754), president of the Royal Society for eleven years; John Freind (1675–1728), who while imprisoned in the Tower began his "History of Physic," and whose release was a condition laid down by Mead when prescribing for Sir Robert Walpole; Thomas Sprat (1635–1713), Bishop of Rochester and first historian of the Royal Society, who concluded his dedication to the King: "Your Majesty will certainly obtain immortal fame for having established a perpetual succession of inventors"; and William Buckland (1784–1856), the well-known Dean of Westminster and twice president of the Geological Society. In the early days of Buckland at Westminster his son, Frank, the discoverer of Hunter's coffin, climbed the roof of the nave and by means of a long pendulum suspended from it repeated Foucault's experiment for showing the rotation of the earth.

Besides the graves of Moray and Barrow already referred to, the south transept contains a monument to Stephen Hales (1677–1761), "pious, modest, indefatigable, and born for the discovery of truth," known to-day for his work on animal and vegetable physiology; and another to Sir John Pringle (1707–82), reformer of military medicine and the predecessor of Banks as president of the Royal Society. It was he who, when the world of science was torn asunder by the controversy over the pointed ends (Franklin's) and the blunted ends (Wilson's) of lightning conductors, made the reply to George III.: "Sire, I cannot reverse the laws and operations of Nature." Buried here is also Sir William Spottiswoode (1825–82), who died while president of the Royal Society.

Only a few more memorials remain to be noticed. Among these, however, is that of Watt. Of all the monuments within the Abbey none has called forth more criticism than Chantrey's great work which dominates the little chapel of St. Paul. "Well might the standard-bearer of Agincourt," wrote Stanley, "and the worthies of the Courts of Elizabeth and James have started from their graves in St. Paul's Chapel if they could have seen this colossal champion of a new plebeian art enter their aristocratic resting-place and take up his position in the centre of the little sanctuary, regardless of all proportion or style in all the surrounding objects. Yet when we consider what the vast figure represents, what class of interest before unknown, what revolutions in the whole actual framework of modern Society, equal to any that the Abbey walls have yet commemorated, there is surely a fitness in its very incongruity." Of Brougham's inscription Stanley said: "It is not unworthy of the omnigenous knowledge of him who wrote it or of the powerful intellect and vast discovery which it is intended to describe."

Watt's great contemporary, Telford, is commemorated by a statue in St. Andrew's Chapel, and here are also to be found the memorials to Matthew Baillie (1761–1823), pupil and successor of William Hunter, physician to George III., and president of the Royal College of Physicians; Sir Humphry Davy (1778–1829), discoverer of potassium and sodium, and inventor of the miner's safety lamp; Thomas Young (1773–1829), founder of physiological optics, and called by Rankine "the most clear-thinking and far-seeing mechanical philosopher" of his time; and lastly that to Sir James Young Simpson (1811–70), the great Edinburgh surgeon, by whose efforts "the fierce extremity of suffering has been steeped in the waters of forgetfulness." It is here, between the statues of Telford and of Mrs. Siddons, and above the memorials to Baillie and Davy, that the tablet to Lord Rayleigh has been placed. The chapel itself forms part of the aisle of the north transept, to which entrance is gained through the gates of the Ambulatory. Sir John Franklin, Admiral McClintock, who discovered the relics of the Franklin expedition, and Admiral Kempenfelt, all have their monuments here, while across the transept can be seen the window erected to the memory of the officers and men who were drowned in the Bay of Biscay through the capsizing of H.M.S. *Captain*, an eloquent reminder of the necessity of making adequate scientific research before embarking upon a great practical experiment.

The Nitrogen Problem.[1]

THE results of a detailed examination of the problem of nitrogen fixation were given in the comprehensive Final Report of the Nitrogen Products Committee of the Ministry of Munitions, published in 1920, and already noticed in these columns (vol. 104, pp. 533 and 569; vol. 105, p. 201). As the Ministry of Munitions is no longer in existence, the Department of Scientific and Industrial Research has arranged for the publication of the additional statistical information which has been accumulated since that time. This Supplementary Report has been drawn up by Dr. J. A. Harker, the director of the Nitrogen Research Laboratory under the Ministry of Munitions. It deals with the statistical aspect of the Chile nitrate industry, the saltpetre industry, the nitric acid industry, the ammonium sulphate industry, the synthetic ammonia industry, the Norwegian fixation industry, the cyanamide industry, the ammonia oxidation industry, and the fertiliser industry. It includes, in addition, a variety of miscellaneous statistics relating to the world's production of fixed nitrogen, national internal sources of fixed nitrogen, the world's fixation plants and power requirements, and the prices of nitrogen fertilisers in England and Germany. The whole concludes with a reference to the present position of nitrogen fixation in this country.

One of the most remarkable of post-war experi-

[1] Statistical Supplement to the Final Report of the Nitrogen Products Committee of the Ministry of Munitions. Department of Scientific and Industrial Research. (Published by H.M. Stationery Office, 1921.) 1s. net.

ences is to be seen in the widespread demand for fixed nitrogen products, especially in the form of fertilisers. In certain countries it is found that although the potential output has been greatly increased by the provision of large fixation plants during the period of the war, yet the total demand for fixed nitrogen is growing at an even greater rate. The same phenomenon is seen in the United Kingdom, which mainly relies upon imported Chile nitrate and home-made sulphate of ammonia. The consumption of nitrogenous fertilisers in 1919 was nearly two and a half times that in an average year before the war. The world's resources in nitrogen products have doubled during the last eight years. It is, however, to be remarked that while the percentage of the whole output contributed by the Chile nitrate industry decreased to one-half, the proportion contributed by the fixation industries has increased from 4½ per cent. of the whole in 1912 to 43 per cent. in 1920 —*i.e.* an increase in percentage of tenfold. The fixation industries are, in fact, now the largest contributors to the nitrogen requirements of the world. Cyanamide plant was largely extended during the war, and its present potential output is larger than that of any other fixation process.

The Supplement contains a series of tables dealing with the world's consumption of Chile nitrate during the war period, the total shipments and the British consumption during the same period, and the amount used for fertilisers and that allocated for war purposes. The figures, as might be expected, show violent fluctuations, due to a variety of causes, such as labour difficulties in Chile, shortage of coal, difficulties of transport, excessive freight charges, liquidation of war stocks, etc. The statistics are interesting, but as they are wholly abnormal it would serve no useful purpose to analyse them in detail.

As regards the saltpetre industry, it is noteworthy that whilst of the imports into the United Kingdom about two-thirds came from Germany, this during the war period was more than replaced by the growth of the Indian industry, which in 1916 attained more than six times its pre-war extent. In 1919 the supply from this source had declined to about one-third its maximum amount.

It need scarcely be said that the war had an enormous influence on the nitric acid industry. The annual pre-war production of nitric acid in this country was estimated at 15,000 tons of 100 per cent. acid, mainly for the manufacture of dyestuffs and explosives. The output in 1917 reached 237,000 tons, of which only 12,000 tons were used for other purposes than explosives.

The available information relating to the production of by-product ammonium sulphate is admittedly incomplete. During the war the market price, of course, steadily rose, and in 1919 the average price in the home market was nearly double that in 1914; the export price was 26*l.* 12*s.* 8*d.* f.o.b. U.K. ports. Germany, which heads the list of consumption, uses at the present time nearly double the amount consumed in the United Kingdom. In fact, she utilises nearly one-third of the world's consumption, mainly, of course, as a fertiliser.

As regards the synthetic ammonia industry, which is practically confined at present to Germany, it is estimated that the combined maximum output of the works at Oppau, and Merseburg when completed, will be about 1050 metric tons of ammonia per diem.

The Norwegian fixation industry has steadily developed since 1913. It is concerned with the synthetic production of the nitrates of calcium, ammonium and sodium, sodium nitrite, calcium cyanamide, and, intermittently, of nitric acid.

It is interesting to note that the general impression, sedulously cultivated by a certain section of German manufacturers, that the cyanamide industry is doomed is not borne out by the facts. There was a rapid extension of it during the period of the war, the world's production in 1917 being about three times that of 1914. Nine new works were erected in France, and the U.S. Government established in Alabama what is now the largest cyanamide factory in the world, with a capacity of about 200,000 tons of 20 per cent. cyanamide annually. As has already been stated, the cyanamide process is still the largest contributor to the world's nitrogen supply by fixation methods.

The ammonia oxidation industry practically owes its development to the war, due to Germany's imperative need for nitric nitrogen when her external supplies were cut off. Plants were also erected in America, France, Italy, and other countries, but complete statistics of production are not available. Details are given in the Supplement of the total annual output of two plants in Germany and two in America, amounting in the aggregate to 450,000 tons of 100 per cent. nitric acid.

An instructive table is given of the world's output of nitrogenous fertilisers, in metric tons, over the period 1910–18, for which complete statistics are alone available. The figures for Chile nitrate and by-product ammonium sulphate fluctuate, but, on the other hand, the synthetic products show a rapid increase, especially in synthetic ammonium sulphate, which is now practically equal to the by-product salt.

Col. White contributes certain statistical tables to the Supplement, one of which affords an approximate measure of the degree of economic independence of the several countries referred to as regards their internal sources of fixed nitrogen. Judged by this standard, Germany has four times the degree of economic independence of this country or of France, and six times that of the United States. Germany need no longer fear that even the most rigorous blockade will interfere with her supply of nitric nitrogen for munition purposes.

Tables are also given of the price of nitrogen

fertilisers in England and Germany, but as the economic conditions in the two countries were, and still are, wholly abnormal and scarcely comparable, it is not easy to determine their actual significance or to forecast their eventual importance.

In conclusion, reference is made to the attempts to develop nitrogen fixation in this country by Messrs. Brunner, Mond, and Co., who have taken over the projected Government factory at Billingham, and by Cumberland Coal Power and Chemicals, Ltd., who are to work the Claude process of synthetic ammonia.

The entire Report constitutes one of the most valuable lessons of the war, and deserves the most serious study. The subject of nitrogen fixation has not yet received the attention in this country which its great importance merits.

Obituary.

EMILE BOUTROUX.

THE death of Emile Boutroux at the age of seventy-six is the loss not only of one who has been for a generation a central figure in the circle of French philosophy, known everywhere in Europe and America, but also of one who by the charm of his personality seemed to embody all that is most attractive in the French genius. It will necessarily cast a gloom on the meeting of the Société Française de Philosophie which is to be held in Paris between Christmas and the New Year and to which English, American, and Italian philosophical societies are sending delegates, for he was to have been its président d'honneur. To those who have known him at former international philosophical congresses his loss will mean much more than his vacant chair.

The last years of Boutroux's life had been saddened by the loss of friends. He felt deeply the death of his brother-in-law, Henri Poincaré, in 1913 at the age of fifty-eight, cut off, as it seemed, in his full intellectual strength. In a conversation with the present writer a few years ago he remarked that his one dearest wish was to be able to show the fruitfulness of Poincaré's ideas in philosophy. In 1919 he lost his wife, who had been for many years his inseparable companion at home and in all his lecture tours in foreign countries. Yet with all the weight of sorrow and the increasing infirmities of old age (he suffered much from deafness and eye trouble) he retained to the end his extraordinary vivacity and charm of conversation and his power of sympathetic control when addressing a meeting.

Emile Boutroux represents a distinct and very important position in the history of contemporary philosophy, especially in relation to the modern scientific revolution. From his student days he devoted his attention to that conception of a universal determinism which, from the time of Descartes down to the great scientific development in the nineteenth century, had seemed to be the absolute and necessary basis of physical science. In 1874 he presented a thesis to the Sorbonne for his doctorate. It was entitled "De la Contingence des Lois de la Nature." For twenty years this book attracted little attention outside the circle of his students and philosophical colleagues. He was fully engaged in lecturing and teaching, and some of his lecture courses were published as studies in the history of philosophy. In 1895, however, at the urgent request of his friends, he republished his thesis in its original form, and since then it has gone through innumerable editions and has been translated into all the principal languages.

The main idea of the thesis Boutroux probably owed to his older contemporary, Lachelier, but the work itself is of striking originality. The argument is that nowhere, not even in the logical syllogism, do we get the type of necessity which is represented by the proposition of identity, A is A, and yet this and nothing short of this will satisfy the ideal of universal science. He went on to prove that the more we advance from the abstract to the concrete, from mathematics to physics, from physics to biology, from biology to psychology, the more we see the range of necessity being restricted and that of contingency growing larger. The suggestiveness of his theory rather than the systematic expression which he was able to give to it marks its importance. It places him in the direct line of that philosophical speculation which, starting with Maine de Biran in the beginning of the nineteenth century, may be traced through Ravaisson, Lachelier, and Boutroux himself to the present philosophers, Bergson, Le Roy, Blondel, and Laberthonière, all of whom were at one time his pupils.

H. W. C.

PROF. PETER THOMPSON.

PROF. PETER THOMPSON, whose untimely and deeply lamented death occurred at Penmaenmawr on November 16, early showed an unusual aptitude for human anatomy. He obtained a special mark of distinction in the subject when a student, and it gained him the gold medal on taking the M.D. (Victoria) from Owen's College, Manchester. He soon won a reputation as a brilliant and enthusiastic teacher after he was appointed senior demonstrator of anatomy at Owen's College. This reputation he fully maintained when he came to London, first as lecturer at the Middlesex Hospital, and later as professor of anatomy at King's College. In 1912 he was elected professor of anatomy and dean of the medical faculty of the University of Birmingham.

Prof. Thompson's contributions to the literature

of anatomy were numerous and valuable. His first, a monograph on the myology of the pelvic floor (1899), was in one sense his greatest. Not only does it give evidence of most painstaking, laborious, and exact work, but it sheds much light on one of the most complex myological problems to be found in the human body. At the instigation of Prof. (now Sir George) Thane, he spent the summer of 1906 in Prof. Wiedersheim's laboratory at the Anatomical Institute of the University of Freiburg, where he studied wax plate reconstruction under Prof. Keibel. Peter Thompson must be regarded as one of the pioneers in this country of wax plate reconstruction as applied to the human embryo, and his description of a 2·5 mm. human embryo of twenty-three paired somites, published in 1907, is now a classic. His whole-hearted enthusiasm and devotion to the new method of investigation infected not only his pupils, but also many colleagues and friends, much subsequent embryological work in this country being due primarily to his example and investigation. He was a most valued and assiduous member of the Anatomical Society of Great Britain and Ireland, serving in turn as secretary, treasurer, and vice-president, and contributing largely to its communications and discussions.

Prof. Thompson had the great gift of human sympathy in a wonderful degree, always took the keenest interest in the activities of others, and was greatly beloved by pupils and colleagues alike. His happy spirit and optimism never failed him even during the many dark days of illness, and his memory will be held precious by all who knew him.

WE regret to announce the death in Montreal on October 25 of SIR JOHN KENNEDY, consulting engineer of the Montreal Harbour Commissioners. From an account of his career which appears in the *Engineer* for November 11 it appears that he became blind in 1907, and at the time of his death he had reached the age of eighty-three years. The Institution of Civil Engineers elected him a member, and for some time he acted as a member of council. He was one of the founders of the Canadian Society of Civil Engineers, of which he was elected president in 1892.

Notes.

ON Thursday, November 24, Field-Marshal Earl Haig, who was accompanied by Lady Haig, unveiled memorials erected to the memory of members of the Institution of Mining and Metallurgy and the Institution of Mining Engineers who fell in the great war. The proceedings were opened by Mr. F. W. Harbord, president of the Institution of Mining and Metallurgy, and Col. W. C. Blackett, past-president of the Institution of Mining Engineers (in the absence of Sir John Cadman, the president). In the course of his address, Earl Haig expressed his satisfaction in having the opportunity to pay a personal tribute to a section of those many thousands of brave men who fought under his command, and to say a few words of special thanks to a body of men whose work in France seldom drew upon itself much notice or glory at the time, but was surpassed by none in the demands it made upon the skill, courage, and resolution of the individuals concerned, or in the service it rendered to the Army as a whole. He then referred in greater detail to the arduous and dangerous work accomplished by the Tunnelling Section of the Royal Engineers at Messines, on the Somme, and in other places, and concluded with an eloquent appeal for those who were left to learn the lessons taught by the men who had given the last full measure of their devotion to the cause they had so worthily upheld. The unveiling of the memorials was followed by a solemn silence of one minute's duration, after which Lord Haig pronounced the words: "Their name liveth for evermore," and the "Last Post" and "Reveille" were sounded. General Sir W. A. Liddell, Director of Fortifications and Works, and other distinguished generals and the officers and councils of the two institutions were present at the unveiling. The memorials are placed in the library at Cleveland House, 225 City Road, E.C.

MR. K. RASMUSSEN'S report of the progress of his expedition has reached Copenhagen. According to the *Times*, the expedition's vessel, the *Sea King*, did not reach the projected station at Lyon Inlet, in Melville Peninsula, until September 8, being delayed by heavy pack and engine trouble. A base was established on a small uncharted islet, named Danish Island, off Lyon Inlet. Mr. Rasmussen is well pleased with the situation as a centre for research, and reports plenty of bears, reindeer, and hares in the neighbourhood. Walrus and seals were seen daily in the sound. Ruins of Eskimo dwellings show that Danish Island was formerly inhabited. Mr. Rasmussen hopes to be able to trace the route of migration of the Eskimo through this region. When the report was dispatched he and a companion were setting out to visit the nearest tribes in the countryside, travelling by dog-sledge. The next report may be expected at the end of April, and will be sent *via* Fort Churchill and Winnipeg.

DR. E. N. MILES THOMAS has resigned the keepership of the Department of Botany of the National Museum of Wales.

A DISCUSSION on "Certain Geological Consequences of the Cooling of the Earth" will be held in the rooms of the Royal Astronomical Society on Friday, December 2, at 5 p.m. The chair will be taken by Sir Jethro Teall. Dr. H. Jeffreys will open the discussion, which will be continued by Dr. Jeans, Prof. Lindemann, Dr. Evans, and Col. E. H. Grove-Hills.

THE Royal Society of South Africa has elected the following officers for 1922:—*President:* Dr. J. D. F. Gilchrist. *Hon. Treasurer:* Dr. L. Crawford. *Hon. General Secretary:* Dr. W. A. Jolly. *Members of Council:* Sir Carruthers Beattie, Mr. S. H. Haughton, Mr. S. S. Hough, Dr. C. J. Juritz, Mr. C. P. Lounsbury, Prof. J. T. Morrison, Dr. A. Ogg, Dr. A. W. Rogers, and Dr. R. B. Young.

WE learn from *Science* that Dr. Harlow Shapley, formerly of the Mount Wilson Solar Observatory, has been appointed director of the Harvard College Observatory in succession to the late Edward C. Pickering, and that Dr. Joel Stebbings, director of the Washburn Observatory and professor of astronomy at the University of Wisconsin, is to succeed Prof. G. C. Comstock as director of the observatory in July next.

THE Trustees of the British Museum have decided to open the Natural History Museum to the public every Sunday from 2.30 p.m. to 6 p.m., commencing next Sunday, and on weekdays from 10 a.m. to 5 p.m. in the winter months, October to February, and from 10 a.m. to 6 p.m. in the summer months, March to September. Previously the hours of admission on Sundays have varied with the season of the year. The museum will be closed on Christmas Day.

LT.-COL. H. H. GODWIN-AUSTEN, Nore, Godalming, asks us to make known that a portfolio of his Indian sketches is missing from the rooms of the Royal Geographical Society, Kensington Gore, London, S.W.7, and he hopes that publicity will lead to its recovery. The portfolio is very large and heavy, about 2 ft. 4 in. by 1 ft. 6 in., strongly bound in black cloth. On the outside cover are set out the names of the countries the sketches were made in—Burma, Kashmir, etc.—the lettering cut out in gilt paper and pasted on. The portfolio contains about 160 sketches in water-colour, sepia, and pencil (a few loose), of which there is nearly a complete list made.

AT the meeting of the Sociological Society held on November 22, a lecture on "The Successors of Austria-Hungary: Some of their Problems" was delivered by Dr. R. W. Seton Watson. Mr. G. P. Gooch was in the chair, and his Excellency the Czecho-Slovak Minister was present, as well as representatives of the Rumanian and Jugo-Slav Legations. Dr. Seton Watson said that of all States Austria-Hungary had been the most complex, presenting not only a great diversity of languages and races, but also a peculiar divergence of culture. Its disappearance had been a unique event in history, similar only to the fall of the Roman Empire, caused, however, not by any general action of other States, but by slow political disintegration due to the lack of any underlying and unifying idea. Criticism of the Treaties of St. Germain and Trianon is easy, but clear-cut frontiers on ethnographical lines are unattainable, such is the intermixture of races. A complete political and social transformation is going on in Europe east of a line from Königsberg to Trieste, the chief, if not the only, citadel of reaction being Hungary. The lecturer went on to give a detailed account of the reforms developing in the succession States, paying a special tribute to the achievement of the Czecho-Slovak Government in the assignment of its various types of lands to the small holders and in education. In Jugo-Slavia, and in Rumania too, education is going forward. In all the succession States religion is becoming democratised and obscurantism has disappeared. We have here a vast laboratory of political, economic, and educational experiments.

MR. T. STEVENS, who laid down the hydraulic plant for the Niagara Power Station so long ago as 1887, gave a very interesting lecture on "Hydraulic Power Development" at Faraday House on November 22. He emphasised the fact that the large water-power undertakings at Niagara, Shawinigan Falls, Montana, etc., had all to wait ten or twelve years before they developed a paying load. In London experts had stated recently that we should build large power stations first, and then the load would be sure to come. Speaking as a hydro-electric engineer, he said that all his experience showed that such a procedure would be financially disastrous. He showed a strikingly beautiful photograph of the Shawinigan Falls enveloped in virgin forest and a recent photograph of the falls with not a tree left and surrounded by unlovely factories and houses. The town, however, has a flourishing population of 12,000, who have been attracted by the cheap power available. He also showed beautiful photographs of the Yguazu Falls, on the border line between Brazil and Argentina, which are among the largest falls in the world. Both the Yguazu Falls and the Victoria Falls on the Zambesi are situated in tropical countries, and the power available varies widely during the different seasons of the year. He pointed out that maximum power does not necessarily coincide with the maximum flow. For instance, a small fall near Yguazu had a 90-ft. drop and a good stream of water in the dry season. In the flood season the falls completely disappeared owing to the raising of the level of the lower part of the river. Owing to the great distances from the nearest centres of population of both the Yguazu and the Victoria Falls, he thought it most unlikely that they would attract an industrial population to their neighbourhood.

IN 1910 Major Patton came to the conclusion that the bed-bug is the invertebrate host of the parasite (the Leishman-Donovan body) of kala-azar, a disease of India and other tropical countries. Major Patton adduces further evidence in the *Indian Journal of Medical Research*, vol. 9, 1921, pp. 240, 252, and 255, in proof of this and Mrs. Helen Adie describes intracellular developmental forms of the parasite in the cells of the stomach of the bed-bug.

PROF. RAYMOND PEARL, in a paper in *Science* (vol. 53, p. 120, 1921), shows the exceedingly transitory effect of war, with its accompanying epidemic and other diseases, upon the rate of growth of population. In Vienna, for example, in spite of the distressing conditions which have prevailed there, it is probable that in 1920 the births will have exceeded the deaths. Prof. Pearl concludes that war and

devastating epidemics make the merest ephemeral flicker in the steady onward march of population growth.

In recent papers, Marshall and Vassalls described a method of treatment of sleeping sickness which, they claimed, gives results better than any other (NATURE, vol. 107, p. 540). It consists in giving intra-venously a dose of neo-kharsivan, and afterwards withdrawing blood and injecting the serum into the spinal canal. In a critical review on the subject in the *Tropical Diseases Bull.*, vol. 18, 1921, p. 155, Dr. Warrington Yorke expresses the opinion that the theoretical grounds upon which the treatment is based are probably incorrect, that the treatment is not new, and that the results so far published fail to substantiate the claim that this treatment gives better results than other methods.

The Ministry of Health has published as No. 9 of the series of Reports on Public Health and Medical Subjects (H.M. Stationery Office, 1921, 3*d.* net) a paper by Dr. J. M. Hamill entitled "Diet in Relation to Normal Nutrition." Dr. Hamill's object was to provide the general public with a straightforward account of the present state of knowledge. The study of nutrition involves a knowledge of highly technical matters, and it is difficult to present even the end results both clearly and truthfully to the mind of an untrained reader. Dr. Hamill has succeeded in combining intelligibility with veracity, and his report should be of great value to those who wish to know more of dietetics than just sufficient to provide material for chatter about vitamins. As so often happens, the daily Press has been responsible for evil as well as good in popular scientific education regarding nutrition. Recent discoveries in connection with accessory food factors have been so striking that the newspaper reader has perhaps rather lost sight of the more prosaic, but not less important, subject of energy values.

The relationship of climate to disease has received more attention in popular talk, based on impressions and individual experiences, than from the exact inquiries of the medical statistician. There can be few places in this country that have not been at one time or another described as "bad for rheumatism" by some inhabitant. A paper by Dr. Matthew Young (*Journal of Hygiene*, vol. 20, p. 248) on the regional distribution of rheumatic fever is therefore all the more welcome. He shows that it is definitely more common, as judged by fatalities, in the north and west than in the midlands, east, and south of the British Isles, and finds substantial correlations, positive between the death-rate and the mean annual rainfall and negative between the death-rate and the mean annual temperature. The data are plainly open to the criticisms which can be made of any of the mass figures of the Registrar-General, but Dr. Young seems to have made out a strong case for an association between acute rheumatic infection, a high rainfall, and a low temperature. There are many things which show the same difference between the north-west and south-east in this country—*e.g.* many animals and plants, the relative abundance of oats and wheat in cereal crops—and one which is particularly relevant in questions of disease and scarcely susceptible of numerical expression is the general standard of civilisation.

No definite instance of sexual differences in colour among Chelonia appears to have been clearly established. Considerable interest, therefore, attaches to the observations of Mr. S. F. Blake (Proceedings of the United States National Museum, vol. 59) on sixty specimens of the spotted turtle, *Clemmys guttata*, showing that this species possesses colour characters distinctive of each sex. The male has dusky jaws, no mandibular yellow-orange stripe, the throat but sparsely speckled with yellow, a slightly developed supra-auricular streak of yellow, and the crown of the head without spots. The female, on the other hand, has yellow jaws, a well-marked mandibular yellow-orange stripe, the throat densely spotted with yellow, a well-developed supra-auricular streak of yellow, and the crown of the head with several yellow spots. It is of special interest to learn that these sexual differences in colour can be detected clearly in very young specimens only a few weeks old.

The director (Dr. E. J. Russell) and librarian (Miss Mary S. Aslin) have published "A Catalogue of Journals and Periodicals in the Library of the Rothamsted Experimental Station, Harpenden." The library began to develop in 1913, when the late Lady Gilbert presented the books and journals belonging to Sir Henry Gilbert. These were added to others previously given by Sir John Lawes. Expansion became possible through the support of many individual donors, learned societies, and Departments of Agriculture throughout the world. The library now contains most of the books and journals which the agricultural expert needs to consult. Though the library is not open to the general public, permission to use it for purposes of reference can be obtained on application to the director. The catalogue, which occupies 70 pages, is divided into sections according to subjects, the first and largest section dealing with agriculture, to which 50 pages are devoted. Other sections are devoted to animal husbandry, bacteriology, biology, botany, chemistry, education, entomology, forestry, horticulture and market-gardening, irrigation and reclamation, meteorology, general science, technology, and zoology. A large number of reports on special subjects are included in the catalogue, but no attempt is made to index individual papers contained in the regular journals. Names of authors do not, therefore, appear. The catalogue should be useful to those who are able from time to time to visit Rothamsted and use its library. It should also serve as an excellent guide to those who wish to get together a collection of authoritative reports on agriculture.

The Kenya Department of Agriculture has published the meteorological records for 1920, the twelfth annual

report for the Colony and Protectorate. At the end of the year there were 21 stations observing temperature and rainfall and 180 stations observing only rain, making a total of 201 stations. The report mentions that the principal feature of the year was the abnormal rainfall experienced generally in November and December. Observations of atmospheric pressure are given for Mombasa, Nairobi, and Londiani; the range in the different months is small. Mean daily levels of Victoria Nyanza for morning and afternoon are given throughout the year 1920, and the average levels are given for each month and for the years 1904–20. There is a sheet of diagrams at the end of the report showing the normal rainfall, also the rainfall for 1920 and its difference from the normal, together with curves showing the monthly rainfall and the difference from the average at twenty-four representative stations. Monthly average rainfall tables for 126 stations are given for a number of years, the period varying from twenty-nine years at Mombasa and twenty-six years at Malindi to as short a time as two years at some stations; there are, however, forty-seven stations with observations for ten years and more. The yearly averages range from 95 in. at Meru (Eyembe Mission) to as little as 7·32 in. at the northern frontier (Wajir). The average monthly totals are generally largest in April and May.

In vol. 22 of the Special Reports on the Mineral Resources of Great Britain, one of the Memoirs of the Geological Survey, Mr. T. Eastwood describes the lead and zinc ores of the Lake District. This district, geologically considered, consists essentially of Cambrian and Ordovician rocks belonging to the Skiddaw and the Borrowdale series, interspersed with a number of igneous intrusions. These rocks are traversed by a number of fissure veins, in many cases accompanied also by faulting, and these veins have given rise to the mining industry here described. The chief gangue mineral is quartz, as might be expected from the character of the country, and galena and zinc blende constitute the minerals of economic value, the former being often rich in silver. The author gives a very full account of the various mines in the district dealt with, which is of great value to the student of British mineral deposits. Unfortunately the district is of no very great economic importance; even in normal times very few of the lodes described are rich enough to form the basis of a steady mining industry. At present, with the prevailing high price of labour, the relatively low prices of the metals extracted, and the high cost and difficulty of transport which further handicap most of them, none of these mines can be worked without loss.

The "Madruckverfahren," or machine-pressure process, is a new plan for the improvement of peat, so that this inferior fuel may be utilised as a substitute for lignite during the present coal scarcity in Germany. The Exhibition of Water-power and Energy in Munich opens up new perspectives by the publication of research material of the Gesellschaft für maschinelle Druckentwässerung in Uerdingen am Niederrhein. The process is based on the fact that the peat-colloid can be influenced if a finely divided additional substance is mixed with the raw peat. The material chosen is that available on the spot, namely, the partially dried peat with 30 per cent. of water. In this way a pressed product of 50 to 60 per cent. water-content is produced. This mixed product already shows a reduction of surface tension and a flocky and crumbly condition due to the particles of dry peat. Thenceforward the humus particles become the dispersion medium and water the dispersed phase. The reversibility in the earlier condition extends to a certain water-content, dried turf showing an irreversible alteration of condition. Ultimately the product is pressed into briquettes like lignite. These statements are extracted from an article by Heinrich Caro on "Veredelung minderwertige Brennstoffe nach dem Madruckverfahren" in *Die Naturwissenschaften*, for September 16. The process may be valuable to Ireland, and even to England—a strange result of depriving Germany of coal.

Under the title "Utilisons la Houille Bleue," *La Nature* for October 29 contains an interesting article by M. H. Lémonon, illustrating a number of the earlier suggestions for developing tidal power by means of mechanisms operated by floats which rise and fall with the tide, or by air which is compressed into a suitable chamber by the rising tide. The article also describes a type of paddle motor in which motion of the paddles is derived from wave impact. While these are of historical interest, none of the methods outlined, nor indeed any such methods, are capable of utilisation on a large scale, and, generally speaking, their capital cost per horse-power of output would be so great as to render them commercially impracticable. The only hope of utilising tidal power on an economic basis would appear to lie in the use of tidal basins, storing water at high tide for use in turbines at periods between high and low tide, and in a following article the author intends to discuss such methods.

A dam may be constructed across a stream for any one of several purposes, such as city water supply, improvement of navigation, hydraulic power, or flood prevention. If suitably located and operated, a dam primarily intended to produce the head for a power scheme may also be utilised to improve the navigation above the dam, to store water for equalising the power output, for preventing floods, and at the same time improving the dry weather flow below the dam. This multiple effect cannot always be realised, but there are occasions when two or more of these functions may profitably be combined, and in an article in the *New Zealand Journal of Science and Technology*, vol. 4, No. 4, for August, 1921, Mr. A. D. Mead deals with the question of the most economical height of dam and the economic size of reservoir to satisfy the necessary requirements in a number of typical cases.

In a paper communicated to the Section of Physiology at a recent meeting of the British Medical Association, and briefly reproduced in the *British Medical*

Journal of October 29, Prof. M. C. Potter, of Newcastle, develops his previous researches in which he showed that the fermentation of cane-sugar by yeast develops an electromotive force. He urges that during the photosynthetical production of carbohydrates from CO_2 and water, electrical as well as thermal energy becomes latent, which is liberated again when the carbohydrate is decomposed, *e.g.* in muscular action, when the E.M.F. developed is proportional to the quantity of carbohydrate used. Similarly, from the fact that the carbon dioxide bubbling off from fermenting sugar is ionised, he proposes that the CO_2 coming from the tissues into the blood is in the same state. Measurements of the E.M.F. of the body as a whole gave very varying results.

ANODE rays produced by means of an anode composed of powdered carbon mixed with a halogen salt of the metal to be investigated, may, according to a paper by Mr. G. P. Thomson in the November issue of the *Philosophical Magazine*, be used successfully to determine the isotopes which are present in lithium, and to show that beryllium is apparently single, but they cannot be used to settle the question for the other alkali and alkaline earth elements. The method used is that in which an electrostatic field of the order of 1000 volts per cm., and a magnetic field of the order of 2000 gauss, act at right angles to the initial path of the anode rays, and produce parabolas on a photographic plate. These parabolas show that lithium consists of isotopes of atomic weights 6 and 7, but no trace is shown in any of the experiments of doubly charged or negatively charged metallic atoms. Parabolas due to the gas in the tube, *e.g.* carbon monoxide, water, fluorine, and iodine, were also detected and measured.

NOS. 1 and 2, for March and June last, of *Terrestrial Magnetism and Electricity* have been combined. Nearly half the combined issue is occupied by a paper by the editor, Dr. L. A. Bauer, on measurements of the electric and magnetic activity of the sun and the earth and interpretations. Various measures of solar activity based on areas of sun-spots, prominences, and faculæ are considered and illustrated graphically. Bidlingmaier's formula for the earth's magnetic activity is criticised adversely, and other measures proposed. The absolute daily range of the horizontal force finds most favour with Dr. Bauer. A deduction from observations made on board the surveying ship *Carnegie*, which if confirmed would be of fundamental importance, is that the diurnal variation of atmospheric electricity potential gradient at sea consists chiefly of a single wave, which progresses according to universal—not local—time, the minimum occurring about 4 a.m., the maximum about 7 p.m. Greenwich civil time. A second paper of considerable interest is an abstract in English of a memoir by Mr. L. Steiner, presented to the Hungarian Academy of Sciences in January last, discussing "a special form of magnetic disturbances" shown by the O'Gyalla magnetograms of the years 1906–17. These are of the "bay" type, but the changes in the several elements differ in phase, so that the force vector rotates. Steiner finds that the vector in the horizontal plane usually rotates clockwise in the morning hours and anti-clockwise in the afternoon. His results appear in general agreement with those derived some years ago from disturbances at Greenwich by Mr. R. B. Sangster, of whose work he seems unaware. There is a portrait and obituary notice of the late Dr. E. Leyst, of Moscow, a voluminous writer on terrestrial magnetism.

WE have received two recent issues of the Spanish popular scientific weekly *Ibérica*, which follows somewhat in its make-up the French *La Nature*. It contains scientific notes from Spanish and Latin-American sources and brief, interesting articles on general scientific subjects. The two issues before us contain a description of the radio-therapeutic laboratory at Granada University and of the biochemical section of the Faculty of Sciences at Saragossa; an account of the excavations carried out in 1920 at Aliseda (Cáceres) and the discovery of Phœnician relics; also a description of discoveries dating back to the Carthaginian age in Spain (at the Tutúgi necropolis), as well as interesting notes culled from foreign sources. This publication should form a valuable medium for the advertising of British scientific instruments and products in Spain and Portugal. The magazine is published in two editions (a cheap edition, and one on special laid paper), the address of the publishers being Apartado 9, Tortosa.

AT a meeting of the Newcomen Society held at Caxton Hall, Westminster, on November 16, a paper was read by Mr. C. F. Dendy-Marshall on "The Liverpool and Manchester Railway." Though built a few years later than the Stockton and Darlington Railway, the Liverpool and Manchester was the first considerable enterprise in railway engineering, and the date of its formal opening, September 15, 1830, may be regarded as the inauguration of the railway systems of the world. On that day eight trains left Liverpool drawn by eight of Stephenson's engines, among the drivers being George Stephenson, Robert Stephenson, Joseph Locke, Thomas Longridge Gooch, and Frederick Swanwick. The famous trial when Stephenson's "Rocket" beat the "Novelty," "Perseverance," and "Sans Pareil," had taken place a year before, October 6, 1829. Costing about 800,000*l.*, the line was thirty-one miles long and had a double track throughout. Just as Boulton and Watts's works at Birmingham became the training-ground of the early mechanical engineers, so the Liverpool and Manchester Railway was the school in which many of the greatest railway engineers gained their first experience. Mr. Dendy-Marshall not only gave much interesting information regarding the line, but he exhibited a fine collection of prints and illustrations, drawings, medals, china, etc., all of which added greatly to the interest of his paper.

WE have received from Messrs. Watson and Sons (Parker Street, Kingsway, W.C.2) their Bulletins Nos. 37 S and 40 S. The former gives particulars of the "Canny Ryall" portable diathermy apparatus.

It consists of a step-up transformer, condensers, spark-gap, and transformer, and is arranged to work off 100–200, and 200–240 volts alternating currents, with periodicities of 50–60. Bull. 40 S gives a list of second-hand electro-medical apparatus, including X-ray sets and accessories, all of which are guaranteed to be in first-rate working order, and show considerable reductions in price over similar new apparatus.

WE are indebted to a correspondent for the suggestion that the name of Dr. Henry Charlton Bastian, F.R.S., who died on November 17, 1915, should be added to the "Calendar of Scientific Pioneers." Bastian was not only a pioneer in neurology, but was also well known as a supporter of the doctrine of "heterogenesis," and for his investigations regarding the origin of life.

Our Astronomical Column.

THE DECEMBER METEORS.—Mr. W. F. Denning writes:—"This event is anticipated with unusual interest this year on account of the brilliant and abundant display observed in 1920. Early in the morning of December 13 meteors were observed to be falling at the rate of about five per minute, and several observers who were not regular meteoric students were attracted to watch the spectacle on account of its special character. The probability, therefore, that another rich return may take place this year renders it necessary that the sky should be attentively watched from about December 10 to December 13. The meteors are moderately swift and the radiant point is close to the star α Geminorum at the time of maximum, but, like the Perseids of August, the Geminids exhibit a radiant point which moves eastward at the rate of about 1° per day. The shower certainly begins early in December, if not late in November, but there appear to be few traces of it left after the middle of December.

"The Geminids have no cometary connection so far as we know, but it is highly probable that this system had its derivation from a comet which either belongs to a past, or the present, age, and probably having a long period of revolution."

THE ORIGIN OF COMETS.—The question whether the comets of long period belong to the solar system or are visitors from outside has been debated in recent years by many astronomers. Prof. G. Armellini contributes another paper on the subject to the September issue of *Scientia*. He points out the insufficiency for this purpose of the method of special perturbations, since this would have to be carried to an impracticable length before it could decide the character of an orbit at a great distance from the sun. Moreover, some who have used the method have failed to take the origin at the centre of gravity of the solar system, the result of this neglect being an apparent oscillation of the orbit from ellipse to hyperbola in a period of twelve years owing to the displacement of the sun by Jupiter.

Prof. Armellini introduces a new argument in favour of the origin of comets within the solar system, asserting that the combined attraction of the stellar system would tend to give closed orbits even to those comets the paths of which are hyperbolic while near the sun. The stellar attraction would be absolutely negligible in the region of space over which ordinary computations have extended, but might become sensible near the aphelia of the long-period comets. The author appears to assert that the stellar attraction would in all cases reinforce that of the sun; this, however, seems not to be the case. The resultant stellar action would evidently be very nearly constant both in magnitude and direction within the region of space in question; hence it would strengthen the sun's action on one side, but weaken it on the other. Unfortunately, our knowledge of the stellar masses is insufficient to form any estimate of the direction in which the resultant acts.

Prof. Armellini appears to make an illegitimate assumption in treating the stellar action as directly proportional to the distance from the centre of gravity of the star-sphere. This law would hold inside a homogeneous sphere, but not in a sphere where the empty regions enormously exceed those occupied by matter.

OBSERVATIONS OF MARS AT FLAGSTAFF.—The observations of Mars carried on for so many years at Flagstaff, Arizona, by the late Prof. Percival Lowell, are still being continued. This is fortunate, for the climate and the excellent 24-inch refractor by Alvan Clark are both well suited to the work. Bulletin No. 83 of the observatory describes the observations made in 1920 by G. H. Hamilton, and reproduces nine drawings made on dates between March 8 and May 26. These dates converted into the Martian Calendar (N. hemisphere), would correspond with July 8 and August 18.

The interesting feature of the opposition was the unusual number of white markings near the east and west limbs, which generally dispersed, or diminished in size, on the central meridian. As they appeared both over desert and dusky regions, and as the canals could be faintly seen through them, it is concluded that they were cloud or mist rather than ground frost. Even the Syrtis Major, usually so prominent, was sometimes almost lost in mist. From the fact that similar drawings were made in 1903 it is suggested that the phenomenon may occur at the same calendar date in each Martian year, but is clearly visible from the earth only once in fifteen years. Attention is also directed to the fact that these whitish areas are not surrounded by dusky borders, as they would be if the theory were true that explains the canals as the boundaries of regions of different tone, showing up more distinctly from the effect of contrast. The absence of the dusky border also supports the objective reality of the dark border round the polar cap.

It was also noted that some of the dusky regions looked unusually dark after they had been cloud-covered, suggesting growth of vegetation after rain. Altogether the observations support the view that there is more "weather" on Mars than has recently been thought probable. However, Mr. Hamilton quotes some similar observations made by Sir Norman Lockyer in the last century, from which Sir Norman concluded that the seasonal changes of Mars are very intense.

The Coming of Age of Long-distance Wireless Telegraphy and some of its Scientific Problems.[1]

IT is just twenty-one years since Senatore Marconi began to equip with wireless apparatus a station at Poldhu in Cornwall for the first attempt at trans-atlantic wireless telegraphy. Until then only appliances of a laboratory type had been used to signal to distances of about 100 miles. This first attempt at long-distance working necessitated the conversion of these appliances into engineering plant employing large power. Although at first the spark system, in which the electric waves are generated by discharges of large electric condensers, was used at Clifden in Ireland and Glace Bay in Nova Scotia, and developed by Senatore Marconi ultimately into the timed spark continuous wave system in the great wireless stations at Carnarvon, N. Wales, New Jersey, U.S.A., and Stavanger, Norway, the usual practice of late years has been to employ either the Poulsen electric arc generator, the high-frequency alternator, or, more recently, the thermionic valve generator. At the recently projected gigantic wireless stations, such as those at St. Assise, near Paris, and Long Island, U.S.A., the high-frequency alternators of Latour-Bathenod and of Alexanderson are to be employed. At the first Imperial wireless station at Leafield, Oxfordshire, erected by the General Post Office to correspond with one at Cairo, the Elwell-Poulsen arc generator is used. The arc generator has, however, the disadvantage that the waves emitted are a mixture of wave-lengths, and not a single pure wave or monochromatic. Important installations of large valve transmitters have recently been made by the Marconi Wireless Telegraph Company at Clifden, Ireland, and at their great Carnarvon station in N. Wales.

The length of waves mostly used for long-distance radio work is between 10,000 and 20,000 metres, or about 6 to 12 miles. It is possible from all large radio stations at the present time to communicate with their antipodes. So far as reception is concerned this long-distance working is entirely due to the thermionic valve, the first type of which was invented by Prof. Fleming in 1904.

It has been proved by the labours of many eminent mathematicians during the last twenty years, however, that the received signals at distances of 6000 to 12,000 miles are many thousands or even millions of times stronger than can be accounted for by pure diffraction or bending of the waves round the earth, and it is now fairly generally agreed that long-distance wireless telegraphy takes place only in consequence of the existence of an electrical conducting layer in the earth's atmosphere at a height probably of from 100 to 200 kilometres.

The presence of this highly conductive layer in the upper regions of the atmosphere, in which the component gases are hydrogen and helium, is probably due to electrified dust which comes to us from the sun being powerfully repelled against the attraction of gravitation by the pressure due to waves of light. This dust comes from the sun with enormous velocity and enters the higher levels of the atmosphere, rendering it an electric conductor. The conducting layer guides the radio waves round the earth and prevents them from escaping into space.

In addition, sunlight ionises the subjacent region during the day, but this is removed during the night. Vagrant natural electric waves are always being produced in the atmosphere, and are called "strays"; they are a serious nuisance in radio signalling at certain times, and especially in the tropics. The great outstanding problem of long-distance wireless telegraphy and telephony is the neutralisation of the effect of these vagrant waves on the receiving apparatus.

Prof. Fleming concluded with some remarks on the bearing on the theory of wireless telegraphy of recent physico-mathematical speculations on relativity, and especially the agnostic view now taken as regards the existence of a space-filling æther. It is clear that space is not a mere vacuum, but has remarkable powers of storing and transmitting energy, but modern physical and astronomical discoveries have rendered necessary great modification in our ideas regarding the structure of space or the æther, and no theory of radiation has yet been propounded which explains satisfactorily all the known facts. We are as yet unable to give any wholly satisfactory explanation as to the nature of the waves used in wireless telegraphy.

[1] Abridged from the fifth Henry Trueman Wood lecture at the Royal Society of Arts, delivered on Wednesday, November 23, by Prof. J. A. Fleming.

Physical Science at the British Association.

JUDGING by the continued interest displayed in the meetings of Section A during the recent visit of the British Association to Edinburgh, the proceedings of this section may be accurately described as very successful. Four strenuous mornings were devoted to the formal work of the section, yet the meeting-place was frequently overcrowded, and, even at the very end of the session, the audience numbered about eighty. There can be no doubt that the policy of the Association in encouraging joint discussions between the sections has met with general approval. Section A participated in two of these, both proving of absorbing interest. It is true that the time occupied by the joint meetings put a severe strain upon the rest of the sectional programme, which was undoubtedly too large, consisting of no fewer than twenty-nine items. This led to the necessity of adopting the somewhat undesirable practice of splitting up frequently into sub-sections; and the question of the limitation of the programme in future years is well worthy of consideration.

Some new departures were made by Section A at the Edinburgh meeting. The afternoon of the first day was made the occasion for demonstrations of novel physical experiments in the laboratories of the Natural Philosophy Department, where also apparatus of historical interest was exhibited. A semi-popular lecture was delivered on another afternoon. Both these new activities of the section met with great success, and ought certainly to be repeated at subsequent meetings. It may be hoped, too, that the excellent arrangements for producing a daily weather report (referred to later) will become a normal part of the work of Section A.

From remarks made earlier in reference to the lengthy programme, it will be understood that in the present report little more can be done than give a list of the papers and authors, with the addition of a few descriptive remarks in cases of outstanding interest. The proceedings opened on the morning of September 8 with a paper by Prof. J. C. McLennan on "Radiation and Absorption by Atoms with

Modified Systems of Extra-nuclear Electrons." The chief point of interest in this work is that by means of a suitable type of discharge it is possible to obtain from potassium two different spectra which correspond closely to the red and blue discharges in argon. Bearing in mind the fact that, according to present-day views of atomic structure, a potassium atom robbed of its valency electron has an outer electron configuration identical with that of argon, Prof. McLennan's results are explained if we suppose that it is electrons in this configuration which are responsible for the radiations he obtained.

Two papers were read by Prof. R. W. Wood, whom the section was fortunate enough to have present in the capacity of foreign guest. In the first of these, "The Time-interval between the Absorption and Emission of Light in Cases of Fluorescence," Prof. Wood described beautiful experiments with a new type of phosphoroscope (capable of recording to 1/400,000 second), which proved that mercury vapour illuminated by the flash of an aluminium spark remains non-luminous for about 1/15,000 second, and then bursts into a flash of green fluorescent light. Nothing but mercury vapour has as yet exhibited the phenomenon. The vapour must be *freshly formed* in order that it may fluoresce; metallic mercury must be present liberating nascent molecules. In his second paper, on "The Spectra of Hydrogen from Long Vacuum Tubes," Prof. Wood described how the use of very long discharge tubes enables the pure Balmer spectrum of hydrogen to be isolated from the continuous secondary spectrum, with the result that *twenty* lines of the series—as compared with thirty in the solar spectrum and but twelve in ordinary laboratory exhibits—can be recorded.

Another distinguished foreign guest, Prof. J. C. Kapteyn, read a paper entitled "First Attempt at a Theory of the Structure and Motion of the Stellar System." In this communication the author gave reasons for supposing that the stars, in the domain where the density exceeds one-hundredth part of the density near the sun, are distributed so that the surfaces of equal density are rotation ellipsoids all with their axes towards the pole of the Milky Way, and for treating them as in rotatory motion in two oppositely directed streams about this axis. By treating the whole system statistically according to the kinetic theory of gases, results are obtained regarding distribution which are in accordance with facts; and, for the region where star-streaming had originally been observed, the relative velocity of the streams calculated agrees almost perfectly with that observed.

Other papers presented during the morning were "Tubes of Force in Four-dimensional Physics," by Prof. E. T. Whittaker; "The Reception of Wireless Waves on a Shielded Frame Aerial," in which Mr. A. A. Campbell Swinton described experiments aiming, without success, at the construction of a unidirectional wireless receiver; and one entitled "Prehensility: A Factor of Gaseous Adsorption," by Prof. H. Briggs.

The afternoon was devoted to demonstrations and exhibitions. Dr. Carse had arranged an exhibit of historical apparatus, and members of the section also visited Prof. Whittaker's mathematical laboratory. Mr. J. J. Dowling gave a demonstration of a recording ultramicrometer, based upon the use of thermionic valves, Dr. W. L. Balls showed his simple harmonic analyser and periodoscope in operation, and Dr. Dawson Turner and Mr. D. M. R. Crombie made several experiments upon the behaviour of an electrified pith ball in an ionised atmosphere. The attendance throughout the afternoon was large.

On September 9 the first item on the programme was Prof. O. W. Richardson's illuminating presidential address on "Problems of Physics." The rest of the morning was devoted to a discussion, jointly with the Chemistry Section, on "The Structure of Molecules," already reported in NATURE of October 13 (p. 218).

More than two hours were spent on the morning of September 12 in discussing "The Quantum Theory." To Mr. C. G. Darwin fell the task of opening this discussion by outlining the theory and the experimental results which had necessitated its adoption. Sir Oliver Lodge communicated to the discussion two notes by Sir Joseph Larmor (afterwards published in the *Phil. Mag.* for October), entitled "Escapements and Quanta" and "Non-radiating Atoms." In the first it was suggested that perhaps atoms behaved like clocks, in that they possessed large stores of energy, not associated with periodicity, but released in quanta by the periodic orbital electrons. In the second note the author gave the conditions which must be fulfilled in order that, with close approximation, there should be no radiation from atoms having orbital electrons except when disturbed. Sir Oliver Lodge in his own contribution suggested that the cause of the change of orbit in the Bohr atom might be the absorption of a bombarding electron by the nucleus, thus reducing the atomic number by unity and necessitating the emission of energy during the establishment of the new stationary state. It was admitted that this view involved the transmutation of elements, but only to so small a degree that the percentage changed would be inaccessible of observation. Prof. J. W. Nicholson dealt with the question of stability in connection with permissible electron orbits in hydrogen and helium, and examined them from the point of view of magnetic properties and characteristic radiation. The connection between quanta and magnetic induction was explained by Dr. H. S. Allen, the results indicating the existence of discrete tubes of magnetic induction as suggested long ago by Faraday. Prof. W. Wilson gave a general mathematical account of the theory, and referred especially to Bohr's principle of analogy, which, although successfully applied to spectra in certain cases, should be regarded as only provisional in character. Some criticism was directed by Prof. J. C. McLennan at Sommerfeld's extension of Bohr's theory in connection with the fine structure of spectral lines. Prof. McLennan's experiments with the lines in the Balmer series of hydrogen did not indicate quantitative confirmation, such as had been claimed in the case of Paschen's work with helium. Dr. Irving Langmuir urged that the mechanism of the quantum theory should be sought for in the electron itself. He believed, for example, that the changes of orbit must be due to discontinuous changes occurring in the structure of the electron, and gave illustrations of what he described as the "quantum state" of the electron. Mr. C. G. Darwin replied to the discussion. Altogether, although of necessity somewhat disjointed, it proved of absorbing interest.

A paper was read by Prof. C. G. Barkla on "The Energy of X-radiation." In this the author explained the distinct properties of scattered X-radiation and fluorescent or characteristic radiation. In the former the laws of classical mechanics apply and all atoms contribute; in characteristic radiation quanta undoubtedly operate, and only a minute fraction of the atoms take part, these being in an abnormal state.

In the Mathematical Sub-Section three papers were

read, viz. by the Rev. J. Cullen in connection with prime numbers, by Dr. F. E. Hackett on a problem in relativity, and by Prof. D'Arcy Thompson on the properties of the tetrakaidekahedron.

In the afternoon Prof. A. S. Eddington delighted a very large audience with a semi-popular lecture on Einstein's theory of relativity.

On the last day of the sectional meetings (September 13) the chief business was the joint discussion with Sections C, D, and K on "The Age of the Earth," already reported separately in NATURE of October 13 (p. 217). There followed several papers of astronomical interest, including "The Microchronograph," by Prof. R. A. Sampson; "The Magnetic Storms of the Present Solar Cycle," by the Rev. A. L. Cortie; and "Discussion of the Radial Velocities of Stars," by Prof. G. Forbes. Earlier in the meeting also Sir Frank Dyson had given an account of the results obtained with the 72-in reflector in British Columbia.

As already mentioned, it was frequently necessary for a sub-section of cosmical physics to meet separately. In this sub-section Dr. A. Crichton Mitchell described the new geophysical observatory recently established in the Shetlands by the Meteorological Office, Air Ministry, for research on problems of terrestrial magnetism and electricity, and particularly work on aurora. Under the title "The Magnetic Anomaly in the District of Kursk, Russia" Prof. A. Kriloff gave an account of the unusually large observed variations of the magnetic elements in the region indicated. Capt. C. K. M. Douglas and Dr. H. Jeffreys, in papers entitled respectively "Some Remarks on Bjerknes's Theories of Cyclones and Anticyclones" and "The Cause of Cyclones," discussed the dynamical and physical conditions relating thereto. Mr. W. H. Dines, in some remarks on "The Discontinuity of Temperature at the Top of the Troposphere," suggested that it might be due to the very gradual sinking and spreading out in higher altitudes of air which had entered the stratosphere in tropical regions. Dr. Hans Pettersson read a paper on "Internal Movements in the Sea," in which he explained, and illustrated experimentally, the influence of the wind on the vertical displacements of strata of different salinity, temperature, density, and biological characteristics off the west coast of Sweden, together with the associated inflow of freshly saturated sea-water through the straits leading to the Baltic. In a paper on "The Dry Period of 1921 in England and Wales" Mr. M. de Carle Salter gave interesting statistics relating to the amount and distribution of rainfall during the recent drought.

An extensive exhibition of diagrams and photographs of meteorological interest, arranged in connection with the Edinburgh meeting of the Royal Meteorological Society, remained open for British Association members. In addition, Dr. Crichton Mitchell exhibited a series of autographic records from the Eskdalemuir Observatory, embracing magnetograms, electrograms, and Galitzin seismograms. Diagrams showing the diurnal variation of atmospheric pollution in normal conditions, during fog, and during the coal strike were shown by Dr. J. S. Owens.

During the meeting a branch of the Meteorological Office, Air Ministry, was established in connection with Section A in the Natural Philosophy Department of the University, and a wireless receiving set for the reception of data was specially installed there by the Communications Department of the Air Ministry. The programme outlined in NATURE of September 8 (p. 44) was carried out, and a daily weather report produced and exhibited in many public places in Edinburgh; while those visiting the rooms of Section A could see on a large blackboard the latest synoptic chart of the weather over an area extending from Spitsbergen southward to the North African coast and from the Azores and Iceland eastward to the Russian frontier. Meteorological and wireless officers were in attendance, who demonstrated to many inquirers the reception by wireless of the meteorological data issued several times daily by European countries, the subsequent charting, and the production of the weather report.

The Ethnology of the Sudan.

A THIRD ethnographical expedition, under the direction of Prof. C. G. Seligman, is being sent out by the Sudan Government with the object of investigating the tribes of the Mongalla province, particularly those along the east bank of the Nile. Prof. and Mrs. Seligman will be joined at Khartum by Mr. S. Hillelson, of the Gordon College. The peoples to be studied include the Bari, the Ascholi, the Madi, and the Latuka, and, if time permits, a trip into the old Lado enclave will be undertaken.

Scarcely any ethnographical information concerning the Latuka has been forthcoming since the time of Sir Samuel Baker (1821–1893), and little is known of them beyond the fact that they are ruled by their hereditary rain-makers, whose ceremonies for drawing down rain have been described. The Madi may be regarded as an entirely unexplored ethnic and cultural field.

The Ascholi are of especial interest, since they speak the Shilluk language, but are known not to share the Shilluk religion; indeed, they do not even know the name of Nyakang. Our knowledge of the Shilluk peoples is derived from the reports of the two previous expeditions undertaken for the Sudan Government by Prof. Seligman. In the winter of 1910 the inhabitants of the banks of the White Nile and the Nubas of southern Kordofan were visited, and in 1911–12 the desert Arabs in the region of the Kordofan-Darfur border and the Hammites of the Red Sea Province.

The Shilluks are a pastoral people numbering about 40,000 who live along the White Nile south of Fashoda and up the Sobat River. Their religion is chiefly king-worship. Their king is believed to be a reincarnation of the semi-divine founder of the dynasty, Nyakang, who is related to the great immanent creator Jŭok. Jŭok is worshipped only through Nyakang, who is the rain-giver of a land where irrigation is not practised. In his reports to the Sudan Government Prof. Seligman described the rain-making and harvest ceremonies of this people, as well as the process for transmitting the spirit of Nyakang to a new king. The reigning monarch is put to death on the first indication of failing powers, usually between the ages of forty and fifty, and a prince is chosen as his successor. The men of Akurwa bring from the shrine to the village of Kwom, near Fashoda, a sacred four-legged stool and an object bearing the name of Nyakang himself, which is believed to be a cylinder or a rude image. At Kwom the king-elect and his chiefs engage in a mock fight with the bearers, who are permitted to win, and escort the king to Fashoda. After a brief sojourn within the shrine the sacred stool

is placed on the ground outside and the mystic "Nyakang" set on it. The king-elect holds one leg of the stool and the highest chief holds another, while members of the royal family stand around. Certain men known as *ororo*, who are said to be descended from the third Shilluk king, kill and eat a bullock, and then place the king on the stool, while the image is taken in to the shrine. At sundown the king rises and is escorted to three newly built huts, where he remains in retirement for three days. During the fourth night he is quietly conducted to his palace, and on the following day gives public audience. The three huts are broken up and cast into the river. The men of Akurwa remain at Fashoda until the end of the dry season.

The divine spirit is thus not congenital, but must be conveyed to each successive monarch. The entry of a royal spirit into an individual is believed to be one of the commonest causes of sickness. Only the early kings take part in this, and they may be induced to leave the sufferer by sacrificial offerings at the appropriate shrine. Certain persons, the *ajuajo*, are regarded as permanently possessed, and these do a brisk trade in healing and the sale of amulets.

Fuel Research.[1]

THE first section, issued separately, of the report of the Fuel Research Board for the years 1920–21 is devoted to an account of experiments made at the Greenwich Experimental Station on steaming in vertical gas retorts. A Glover-West setting was employed, but the ordinary system of working was modified in one or two respects. The setting was fired by water-gas or coal-gas, the quantity of which could be measured, and the air for combustion was supplied under uniform positive pressure. Moreover, the air supply was preheated by the outgoing flue gases at the top of the setting in an exchanger built of steel pipes.

The work may be regarded as complementary to that carried out on the same subject at Uddingston by the Joint Research Committee of the University of Leeds and the Institution of Gas Engineers, and reported last year. It had the same aim of establishing trustworthy technical data for the process of steaming, which is increased in importance by the greater elasticity given to the manufacturers of gas by the provisions of the new Gas Act. Whereas, however, the work of the Research Committee at Uddingston was confined to one Scottish coal, tests have been made by the Fuel Research Board on several coals, including Consett and Mitchell Main gas nuts, although the coal used at Uddingston was included in order to bring the two sets of experiments into line.

This extension of the work to several coals has apparently made it impossible to secure the same construction of chemical balance sheets for carbon, nitrogen, and sulphur, which was a principal part of the work of the Research Committee. Data have been obtained for the increase in gas makes, the production of ammonia, and fuel consumption when operating with different quantities of steam, and as a result the favourable verdict of the Research Committee on the steaming process is confirmed.

A number of interesting tables and graphs, which will repay the critical attention of those specially interested, and a clear diagram of the train of plant which was employed for carbonisation and purification accompany the report. Some suggestions are given for consideration on practical points. One appendix deals with sampling, testing, and analysis, and three others with special points arising in the tests. The whole of the report is a full record of very extensive experimental work carried out on a subject which has been recognised by those associated with the gas industry as of a high order of importance. J. W. C.

[1] Department of Scientific and Industrial Research: Report of the Fuel Research Board for the Years 1920–21. First Section: "Steaming in Vertical Gas Retorts." (London: H.M.S.O., 1921.) 1*s*. 6*d*. net.

University and Educational Intelligence.

BRISTOL.—It has been decided to conform to the practice of most other English universities by granting a diploma (in lieu of a certificate) in engineering to students who, though not qualified for matriculation, pass the entrance examination for admission to the Faculty of Engineering and complete satisfactorily the course of study prescribed for this purpose.

Some years ago a committee was set up by the Faculty of Medicine for organising post-graduate studies for practitioners in and around Bristol, and during this autumn three courses of demonstrations have been given, two in Wiltshire and one in Dorsetshire. These have proved so successful that the committee is projecting a wider campaign, and is offering to arrange courses throughout the south-west of England. Each course consists of six demonstrations, one or more per week, and to each centre a large selection of subjects is offered from which those attending the course may select what seems to them of greatest value. In rural areas all the demonstrations are given by University lecturers, but in the large towns it is hoped to enlist the co-operation of the local hospital staffs. The demonstrations condense into small compass recent advances in the work of the medical profession, and each one is entrusted to a member of the Faculty who has given particular attention to that subject. In this form of University extension work Bristol leads the way so far as Britain is concerned, though we believe that similar work has been undertaken in Canada by the University of Toronto. It is as direct a return as any of the activities of the University for the grant now being made by local authorities.

LONDON.—The Senate has conferred the title of "Professor of Logic and Scientific Method in the University of London" on Dr. A. Wolf, former fellow of St. John's College, Cambridge, and fellow of University College, London. Prof. Wolf is the head of the Department of the History and Method of Science at University College and of Logic and Scientific Method at the London School of Economics and Political Science.

THE annual prize distribution and students' conversazione of the Northampton Polytechnic Institute, Clerkenwell, London, E.C., will be held on Friday, December 2. The Right Hon. Lord Southwark will distribute the prizes and certificates.

TRINITY COLLEGE, Cambridge, offers for the second time a research studentship of a value varying with the need of the student, but not exceeding 200*l*. a year, to a non-member of the University of Cambridge who proposes to enter that University in October, 1922, as a candidate for the degree of Ph.D. Applications should be sent as early as possible in

July next, and not later than July 25, to the Senior Tutor, who will supply further particulars on request.

AT a meeting of the council of the Association of University Teachers, held on November 25 at Bedford College, Regent's Park, the following resolution was carried unanimously :—"That this council of the Association of University Teachers has heard with dismay the proposal of the Lords Commissioners of the Treasury to reduce the annual grant in aid of university education by 300,000*l.*, and protests against the proposal on the ground that it will seriously hamper the work of the universities, impair their efficiency, and in consequence retard their development in the future to the great loss of the nation." Prof. J. Strong, president of the association, stated that the present annual grant from the Treasury to the universities was about one-fifth of the total annual grant for education and one-thousandth part of the revenue of the country.

THE calendar for 1921–22 of University College, London, provides a complete summary of the multifarious courses of instruction which are available during the present session at that college. Particulars are given of the teaching staff in each department, and by means of a series of reference numbers and letters a time-table has been constructed from which information can be obtained as to the exact lectures which students are advised to attend for the various courses suitable for London University degrees. The fellowships, scholarships, and prizes administered by the college are also recorded, together with the regulations affecting each. A number of appendices complete the volume, one of which is devoted to the Provost's report on the past session. As many as 3005 students were attending courses, a number which placed a heavy burden on the members of the teaching staff. In spite of this, however, a list of more than 280 original publications stands to their credit, showing that they still found time to make considerable contributions to the progress of knowledge.

THE Board of Education has published (Rules 100, 1921, 2*d.*) particulars of a scheme in accordance with which arrangements have been made between the Board and the Institute of Chemistry for the award of national certificates in chemistry to students in technical schools and colleges in England and Wales. Under this scheme the institute, in conjunction with the Board, will approve schemes of training submitted by the technical schools or colleges for the award of certificates for part-time and full-time grouped courses, including, in addition to chemistry, suitable courses in physics, mathematics, and cognate subjects. Courses for part-time course certificates will be designated "Senior" for the ordinary certificate and "Advanced" for the higher certificate. Courses for full-time course certificates will be suitable for students who have attended a secondary school up to the age of sixteen years, and will include physics, mathematics, and one or more modern languages, and may include other cognate subjects. These certificates will be awarded in chemistry and in applied chemistry. Admission to the course in applied chemistry will be restricted to students who have satisfactorily completed a full-time course in chemistry or another course approved by the institute and by the Board. The training for the full-time course certificate in chemistry must extend over at least three years, while for that in applied chemistry at least one year will be required. The council of the institute will consider at a later date whether and how far the training and the higher certificates should be recognised as qualifying for admission to the examination for the associateship of the institute.

Calendar of Scientific Pioneers.

December 1, 1866. Sir George Everest died.—Entering the East India Company in 1806 as a cadet, Everest in 1823 succeeded Lambton as superintendent of the Trigonometrical Survey of India. Under his direction the measurement of the arc of meridian from Cape Comorin to the north of India was completed. His name was given to the great peak in the Himalayas.

December 2, 1897. Friedrich August Theodor Winnecke died.—Of Winnecke Gill remarked that he was unquestionably the greatest teacher of practical astronomy since the days of Bessel. From 1872 to 1882 he was director of the observatory at Strassburg.

December 3, 1920. Sir William de Wiveleslie Abney died.—Besides being prominent in all branches of photography, which he did much to develop, Abney did valuable work on spectroscopy, photometry, light, and vision. He served for twenty years in the Royal Engineers, and from 1884 occupied important positions in connection with public education at the Department of Science and Art and the Board of Education.

December 4, 1798. Luigi Galvani died.—While lecturer in anatomy in the University of Bologna, Galvani made many experiments in muscular contraction through electrical influence, and in 1791 published his "De Viribus Electricitatis. . . ."

December 4, 1893. John Tyndall died.—Commencing life as a railway engineer, Tyndall, in 1853, at the age of thirty-three, became professor of natural philosophy at the Royal Institution, a post he held until 1887. Like Huxley a fearless champion of freedom of thought, he was widely known for his work on diathermancy, diamagnetism, and the flow of glaciers, his lectures, and his books, among which was "Heat, a Mode of Motion," while as a mountaineer he was the first to ascend the Weisshorn.

December 5, 1859. Louis Poinsot died.—A student, professor, and examiner of the Ecole Polytechnique, Poinsot, in 1803 published his "Eléments de Statique," which contained his theory of couples, and in 1834 his "Théorie nouvelle de la rotation des corps," dealing with the motion of a rigid body.

December 5, 1902. Johannes Wislicenus died.—The successor of Strecker at Wurzburg, and of Kolbe at Leipzig, Wislicenus devoted himself to organic chemistry, and did pioneer work in stereochemistry.

December 6, 1771. Giovanni Battista Morgagni died.—The founder of pathological anatomy, Morgagni was a professor at Padua. In 1761, in his eightieth year, he published the result of his life's work, "Anatomical Researches into the Seats and Causes of Disease."

December 6, 1799. Joseph Black died.—Called by Fourcroy "the Nestor of the chemistry of the eighteenth century," Black made his two great discoveries of carbonic acid and latent heat in 1754 and 1761 respectively, and to him is due the principle of specific heats. As a student he was much influenced by Cullen, whom he succeeded in the chairs of chemistry at Glasgow and at Edinburgh. The date of his death is often given erroneously as November 10 or November 26.

December 7, 1912. Sir George Howard Darwin died.—The second son of the great naturalist, Darwin, from 1883, was Plumian professor of astronomy and experimental philosophy at Cambridge. His principal researches related to gravitational and tidal problems, and the stability of planetary orbits. He was knighted in 1905, and in 1911 received the Copley medal of the Royal Society. E. C. S.

Societies and Academies.

LONDON.

Geological Society, November 9.—Mr. R. D. Oldham, president, in the chair.—L. D. **Stamp** and S. W. **Wooldridge**: The igneous and associated rocks of Llanwrtyd (Brecon). Pt. 1: Stratigraphical (L. D. S.). The succession of rocks is given; the fossils from the lower horizon include *Dicranograptus rectus*, Hopkinson, *Glyptograptus teretiusculus*, var. *siccatus*, Elles and Wood, and *Climacograptus schärenbergi*, Lapworth; those from the higher horizon include *Dicellograptus sextans*, Hall, and var. *exilis*, Elles and Wood, and *Glyptograptus teretiusculus*, var. *siccatus*, Elles and Wood. Both assemblages are characteristic of the Dicranograptus shales of South Wales. The volcanic rocks of Llanwrtyd are therefore of lowest Bala (Survey classification) and on the same horizon as the upper basic and upper acid series of Cader Idris. The igneous rocks are cut off on the west by a fault, into which an intrusive mass appears to have been forced. Pt. 2: Petrographical (S. W. W.). The Lower Ashes are an acid series, of which the most characteristic member is a coarse flinty breccia. The spilites show pillow-structure in the upper part, but pass down into massive, finely vesicular rocks. The spilites are locally associated with spilite-breccias, consisting of angular fragments of various rocks and rounded bombs, of all sizes, of spilitic material. The bands of fine ash frequently interbedded with the sediments form dark flinty rocks weathering white. The intrusion is an enstatite-bearing rock of doubtful affinities.—L. D. **Stamp**: The base of the Devonian, with special reference to the Welsh borderland. The Ludlow Bone-bed forms a natural base: it consists of fish remains, all of which first appear at this horizon, and are genetically connected with higher Devonian faunas; it passes laterally into a conglomerate, and thus forms a natural physical base; it marks a palæontological and lithological break which can be correlated all over north-western Europe. The fauna of the lower beds (Ludlow Bone-bed, Downton-Castle Sandstone, and Platyschisma Shales) falls into three groups:—(*a*) Upper Ludlovian marine species which survived the change of conditions indicated by the bone-bed, but gradually died out; (*b*) species which flourished for a short time under the changing conditions; and (*c*) new forms, chiefly fishes, which persist, or are closely connected with later Devonian forms. It is suggested, from the association of the early Downtonian fishes with marine invertebrates, that the former could live in either salt or brackish water, but gradually became specialised.

Royal Meteorological Society, November 16.—Mr. R. H. Hooker, president, in the chair.—H. **Jeffreys**: The dynamics of wind. Winds can be divided into three main groups according as the pressure differences between places at the same level are mainly occupied in producing acceleration relative to the ground, in guiding the wind under the influence of the earth's rotation or in overcoming friction. They are called Eulerian, geostrophic, and antitriptic respectively. Tropical cyclones and tornadoes are Eulerian, while all winds of side extent are approximately geostrophic; sea and land breezes and mountain and valley winds are mainly antitriptic. Temperature differences will account for the annual pressure variation in Asia, and probably for the permanent winds of Antarctica. In the case of mountain and sea breezes a fundamental part is played by the deviation of the actual average temperature lapse-rate from the adiabatic value.—N. K. **Johnson**: The behaviour of pilot-balloons at great heights. Wind-structure in the upper atmosphere is generally investigated by following a pilot-balloon by means of a theodolite, though at a few stations the balloon is followed by two theodolites situated at the ends of a base-line. Single-theodolite determinations rest fundamentally upon the assumption that the rate of ascent of the balloon is uniform. When a pilot-balloon is observed with two theodolites at the ends of a base-line the actual height of the balloon is calculated from minute to minute, and this method affords a means of testing the accuracy of the single-theodolite method. Experiments on the leakage of pilot-balloons are also detailed. It is concluded that the results of single-theodolite pilot-balloon ascents carried to great heights must be received with great caution.—C. J. P. **Cave**: The cloud phenomenon of November 29, 1920. On November 29, 1920, a cloud with a sharp-cut edge passed across the east of England, and was observed as far north as Worksop, Nottinghamshire, and as far south as Hawkhurst, Kent. The cloud moved from the west; in front the sky was clear, behind completely overcast. The progress of the front has been mapped from sunshine records and observers' notes, and the upper-air conditions have been investigated.

Royal Microscopical Society, November 16.—Mr. D. J. Scourfield, vice-president, in the chair.—G. **Patchin**: The micro-examination of metals, with special reference to silver, gold, and the platinum metals. The presence of foreign bodies, the existence of small quantities of metals, metalloids, etc., which may or may not exert an injurious effect on the material, the constitution of alloys, and the distribution of constituents throughout the metallic mass in relation to the micro-examination of metals, were discussed briefly. The presence of platinum and the platinum metals in gold, silver, and gold-silver alloys and the effect of small quantities of these metals on the surface appearance of cupellation beads were described.—W. C. **Crawley** and H. A. **Baylis**: Mermis parasitic on ants of the genus Lasius. The winged females of ants of the genus Lasius frequently show structural peculiarities, especially stunted wings and atrophy of the ovary, which are the result of infection with a Nematode worm. As Nematodes of this family (Mermithidæ) remain in a larval condition until after emerging from their hosts, complete description of them involves keeping them alive until they attain maturity. This has been done with the form found in *Lasius alienus*, *L. flavus*, and *L. niger*. No mature males of the worm were obtained; since the larvæ were found to have a precociously-developed male gland, the species is possibly a protandrous hermaphrodite. This view is supported by the observation that oviposition begins before or during the shedding of the last larval cuticle.—R. L. **Frink**: The practical value of the microscope in glass manufacture. The use of the microscope as a preventive control in selecting raw materials used as constituents of glass batch and refractories and materials for furnaces and the detection by means of the microscope of the causes of atriæ or cords, stones, seeds, blisters, and other defects in glassware were described. The value of supplementing the polariscope tests of the annealing of glass by microscopical tests was also urged.

Linnean Society, November 17.—Dr. A. Smith Woodward, president, in the chair.—A. Smith **Woodward**: A newly-discovered human skull from the Rhodesia Broken Hill Exploration Company's mine in N.W. Rhodesia. The skull evidently belonged to an extinct race of cave-men, with a skull much resembling that

of the European cave-men of the Neanderthal race, but with an erect skeleton.—A. W. **Hill**: A visit to the Cameroons and Nigeria. The settlement of Victoria and the Botanic Garden there were described. Connected with this garden are the experimental plots of tea and cinchona at Buea, at an altitude of 3300–3600 ft. on the Cameroon Mountain. The Bauchi Plateau, Northern Provinces, was visited, and arrangements were made for collecting specimens of the local flora. More than 600 specimens, comprising a large proportion of new species, have been sent to Kew. The flora of the plateau shows affinities with the flora of Abyssinia and Nyasaland.

PARIS.

Academy of Sciences, November 14.—M. Georges Lemoine in the chair.—P. **Painlevé**: Gravitation in the mechanics of Newton and in the mechanics of Einstein.—M. **Hamy**: A particular case of diffraction of the images of the circular stars and the determination of their diameters.—L. **Fabry**: New formulæ for the calculation of the line of search of a minor planet.—MM. **Gonnessiat** and **Renaux**: An asteroid with an orbit resembling that of a comet. This planet (1920 HZ) was discovered by M. Baade at the Babelsberg Observatory, and he noted its comet-like orbit. Between December 1, 1920, and March 2, 1921, eight positions of this star were obtained with the photographic equatorial of Algiers Observatory, from which the provisional elements have been calculated. The orbit reaches to the distance of Saturn, but the image is clearly that of a planet, and not a comet. Additional observations are desirable before the end of the year, as it will not return for thirteen years.—B. **Déirmendjian**: A new demonstration of a theorem of M. Picard, and some generalisations of this theorem.—J. **Kampé de Fériet**: The general integral of the systems of partial differential equations of hypergeometric functions of higher order.—A. **Lévy**: Recurrent series and the homogeneous forms depending on them.—R. **Gosse**: Two new types of partial differential equations of the second order and of the first class.—J. **Chazy**: The arbitrary functions appearing in the ds^2 of the Einstein gravitation.—R. **Guillery**: Testing machines giving the elastic limit and the modulus of elasticity of metals.—K. **Ogura**: The theory of gravitation in space of two dimensions.—J. **Chappuis** and **Hubert-Desprez**: Researches on stray currents. The stray currents in the soil (of Paris) are produced by insulation defects of the tramway networks (550 volts, continuous current), and cause considerable damage to water and gas mains. Two methods have been worked out for identifying the leaky circuit, one based on the telephone, the other on the lamp with three electrodes. The latter proved to be the better method.—L. **Bouchet**: The variation with time of the pressures created in insulating fluids by a constant electrostatic field. The change with time may be interpreted in several ways, the most probable being the assumption that there is a change in the conductivity of the liquid. The effects observed with alternating currents were applied to calculate the specific inductive capacities of the six hydrocarbons used in the experiments.—P. **Lemay** and L. **Jaloustre**: The oxidising properties of certain radio-active elements. The experiments were made with the bromides of mesothorium, radiothorium, thorium-X, and radium. If solutions of these salts, enclosed in bulbs, are placed in the oxidisable solutions, there is no action, but when intimately mixed, oxidation phenomena were observed with hydroquinone, tincture of guaiacum, ferrous salts, and acid solutions of iodides.—P. **Glangeaud**: The Plomb du Cantal, a large independent volcano, covering nearly a third of the Cantal massif. This region has hitherto been considered as representing a sector of the great Cantalian volcano with a single crater. The author's observations lead to the conclusion that the Plomb du Cantal is an independent volcano, the principal eruptive centre of which was asymmetric with respect to its lava streams.—P. **Loisel**: The radio-activity of the springs of the region of Bagnoles-de-l'Orne. The eight springs examined all proved to be radio-active, but in different degrees. In four of them, all coming from granite, the radio-activity was permanent. The variations are discussed from the point of view of a double origin of the water from the spring.—Ed. **Le Danois**: The variations of the Atlantic waters off the French coasts.—J. **Eriksson**: New biological studies on the rust of mallow, *Puccinia Malvacearum*.—J. **Ripert**: The biology of the belladonna alkaloids.—P. **Freundler**, and Mlles. Y. **Menager** and Y. **Laurent**: Iodine in the Laminaria. There is a loss of iodine, which may amount to 50 per cent. of the amount originally present, when the algæ are dried. The percentage of iodine is almost independent of the place of growth, but varies with the time of year.—A. **Němec** and F. **Duchoň**: The possibility of determining the value of seeds by the biochemical method. An attempt to find a relation between the different enzymes present in the seed and the power of germination. The hydrolysing diastases can persist after the seed has lost its germinating power. But catalase behaves differently, and the activity of the catalase may serve to evaluate in a few minutes the agricultural value of the seeds.—G. **Hinard** and R. **Fillon**: The chemical composition of the starfish. Dried starfish contain about 50 per cent. of calcium carbonate, 35 per cent. of albumenoids, and 7 per cent. of fat, and serve well for manure. The fat has been extracted, and some of its chemical and physical constants are given.—R. **Bayeux**: The subcutaneous absorption of oxygen in mountain climbing or ascent by aeroplane.—A. **Tournay**: The influence of the sympathetic nerve on the sensibility: the effects of the resection of the sympathetic on the residual sensibility of a member the nerves of which have been almost completely severed.—A. **Labbé**: Heterogeneous impregnation.—P. **de Beauchamp**: Biogeographical researches on the tidal zone at the island of Yeu.—R. **Poisson**: Brachypterism and apterism in the genus Gerris.—M. **Aynaud**: Contagious pustulous stomatitis in sheep and goats.—G. B. **de Toni**: Material for the reconstruction of the manuscript A of Leonardo da Vinci in the library of the Institute.

BRUSSELS.

Royal Academy of Belgium, November 5.—M. G. Cesàro in the chair.—C. **Servais**: The geometry of the tetrahedron.—L. **Godeaux**: A rational involution with three points of coincidence belonging to an algebraic surface of the third species.

Books Received.

Wages and the Cost of Living. By Dr. C. V. Drysdale. Pp. 51. (London: Malthusian League.) 6*d*.

The Malthusian Doctrine and its Modern Aspects. By Dr. C. V. Drysdale. Pp. 68. (London: Malthusian League.)

Problems made Easy for Preparatory Schools and the Lower Forms in Public Schools. By R. Tootell Pp. 75. (Winchester: Warren and Son, Ltd.) 3*s*. net.

Alternating Currents. By G. C. Lamb. Part 1. Pp. viii+73. Part 2. Pp. viii+127. (Cambridge:

At the University Press.) Part 1, 5s. 6d. net; part 2, 7s. 6d. net.

Market Nursery Work: A Series of Six Books on the Cultivation of Crops for Market. By F. J. Fletcher. Vol. 1: Glasshouses and the Propagation of Plants. Pp. viii+75. Vol. 2: Special Glasshouse Crops. Pp. vi+72. (London: Benn Bros., Ltd.) 4s. 6d. each.

Penrose's Annual. Vol. 24 of the Process Year Book and Review of the Graphic Arts, 1922. Edited by W. Gamble. Pp. xii+91+plates. (London: Percy Lund, Humphries and Co., Ltd.) 8s. net.

Ocean Research and the Great Fisheries. By G. C. L. Howell. Pp. 220+20 plates+3 maps. (Oxford: Clarendon Press.) 18s. net.

Letters to My Grandson on the World About Him. By the Hon. Stephen Coleridge. Pp. 124. (London: Mills and Boon, Ltd.) 4s. net.

The Handicraft Art of Weaving. By T. Woodhouse. (Oxford Technical Manuals.) Pp. xii+165. (London: Henry Frowde and Hodder and Stoughton.) 6s. net.

A Text-book of Inorganic Chemistry. By Prof. A. F. Holleman. Sixth English edition, revised. (Issued in English in co-operation with H. C. Cooper.) Pp. viii+528. (New York: J. Wiley and Sons, Inc.; London: Chapman and Hall, Ltd.) 19s. net.

Elementary Chemical Microscopy. By Prof. E. M. Chamot. Second edition, partly re-written and enlarged. Pp. xvi+479. (New York: J. Wiley and Sons, Inc.; London: Chapman and Hall, Ltd.) 25s. net.

The Emission of Electricity from Hot Bodies. By Prof. O. W. Richardson. (Monographs on Physics.) Second edition. Pp. viii+320. (London: Longmans, Green and Co.) 16s. net.

Ministry of Munitions and Department of Scientific and Industrial Research. Technical Records of Explosives Supply, 1915–1918. No. 4: The Theory and Practice of Acid Mixing. Pp. vi+93. (London: H.M. Stationery Office.) 12s. net.

The Psychology of Medicine. By Dr. T. W. Mitchell. Pp. viii+187. (London: Methuen and Co., Ltd.) 6s. net.

Annual Report of the Meteorological Committee to the Air Council for the Year ended 31st March, 1921. Pp. 72. (London: H.M. Stationery Office.) 2s. net.

The Historical Geography of the Wealden Iron Industry. By M. C. Delany. (Historico-Geographical Monographs.) Pp. 62+3 maps. (London: Benn Bros., Ltd.) 4s. 6d. net.

La Matière et l'Energie: Selon la Théorie de la Relativité et la Théorie des Quanta. By Prof. L. Rougier. Nouvelle edition. Pp. xii+112. (Paris: Gauthier-Villars et Cie.) 9.50 francs.

The Manufacture and Uses of Explosives, with Notes on their Characteristics and Testing. By Dr. R. C. Farmer. (Technical Primer Series.) Pp. xii+116. (London: Sir I. Pitman and Sons, Ltd.) 2s. 6d. net.

Dictionary of Botanical Equivalents. French-English: German-English. By Dr. E. Artschwager and E. M. Smiley. Pp. 137. (Baltimore, Md.: Williams and Wilkins Co.) 2 dollars.

Vorlesungen über Thermodynamik. By Prof. Dr. Max Planck. Sechste auflage. Pp. x+292. (Berlin and Leipzig: W. De Gruyter and Co.) 1.28 shillings.

Meddelelser fra Kommissionen for Havundersøgelser. Serie Fiskeri. Bind 6, Nr. 2, 1021: Danish Investigations of Plaice from the North Sea, July, 1919-July, 1920. By Dr. K. Smith. Pp. 68. (København: C. A. Reitzel.)

Diary of Societies.

THURSDAY, DECEMBER 1.

LINNEAN SOCIETY OF LONDON, at 5.—Prof. W. N. Jones: Note on the Occurrence of Brachiomonas.—J. Burtt-Davy: The Distribution of Salix in South Africa.—Miller Christy: The Problem of the Pollination of the British Primulas.

ROYAL AERONAUTICAL SOCIETY (at Royal Society of Arts), at 5.30.—Major C. H. Scott: The Present State of Airship Development.

INSTITUTION OF ELECTRICAL ENGINEERS, at 6.—L. J. Steele and H. Martin: The Cyc-arc Process of Automatic Electric Welding.

ROYAL MICROSCOPICAL SOCIETY (Metallurgical Section), at 7.30.—The Practical Application of Vertical Illuminators in the Determination of the Structure of Metals and Alloys and in Metallographical Research Generally. Exhibition of Various Types of Vertical Illuminators by C. W. Hawksley and P. Swift.

CHEMICAL SOCIETY, at 8.—R. Mond and A. Wallis: Some Researches on the Metallic Carbonyls.—R. Mond and A. Wallis: The Action of Nitric Oxide on the Metallic Carbonyls.

ROYAL SOCIETY OF MEDICINE (Obstetrics and Gynæcology Section), at 8.—R. H. Paramore: Eclampsia and its Incidence.

CAMERA CLUB (at 17 John Street, W.C.2), at 8.15.—Madame Yevonde: Women in Photography.

FRIDAY, DECEMBER 2.

ROYAL SOCIETY OF MEDICINE (Laryngology Section), at 4.45.

ROYAL ASTRONOMICAL SOCIETY, at 5.—Geophysical Discussion: Certain Geological Consequences of the Cooling of the Earth. Opened by Dr. H. Jeffreys, continued by Dr. Jeans, Prof. Lindemann, Dr. Evans, and Col. Grove-Hills. Chairman, Sir Jethro Teall.

INSTITUTION OF ELECTRICAL ENGINEERS (Students Section), at 7.—H. S. Petch: Automatic and Semi-automatic Railway Signalling.

JUNIOR INSTITUTION OF ENGINEERS (at Caxton Hall), at 8.—B. L. Ladkin: Notes on Maintenance of Electrical Accumulators.

ROYAL PHOTOGRAPHIC SOCIETY OF GREAT BRITAIN, at 8.—M. O. Dell: Ideals and Methods in Picture Making.

ROYAL SOCIETY OF MEDICINE (Anæsthetics Section), at 8.30.—Informal Meeting.

SATURDAY, DECEMBER 3.

GILBERT WHITE FELLOWSHIP (at 6 Queen Square, W.C.1), at 3.—Prof. G. S. Boulger: The Sundews: Their Kindred and Neighbours.

MONDAY, DECEMBER 5.

ROYAL BOTANIC SOCIETY OF LONDON, at 3.—Prof. A. W. Bickerton: Gardening (1).

VICTORIA INSTITUTE (at 1 Central Buildings, S.W.1), at 4.30.—Rev. A. C. Robinson: Darius the Median and the Cyropædia of Xenophon in the Light of the Cuneiform Inscriptions.

ROYAL INSTITUTION OF GREAT BRITAIN, at 5.—General Meeting.

SOCIETY OF ENGINEERS (at Geological Society), at 5.30.—W. M. Beckett: Northwich Sewerage and Sewage Disposal Works.

INSTITUTION OF ELECTRICAL ENGINEERS (Informal Meeting), at 7.—C. L. Lipman and others: Discussion on Some Recent Developments in the Design of A.C. Instruments.

ARISTOTELIAN SOCIETY (at 21 Gower Street, W.C.1), at 8.—Prof. J. Johnstone: The Limitations of Knowledge.

ROYAL INSTITUTE OF BRITISH ARCHITECTS, at 8.—Business Meeting.

ROYAL SOCIETY OF ARTS, at 8.—A. M. Hind: Processes of Engraving and Etching (Cantor Lecture) (2).

SOCIETY OF CHEMICAL INDUSTRY (at Chemical Society), at 8.—W. L. Baillie: An Autoclave Test for the Grading of Chemical Glassware.—Dr. E. Fyleman: Separation of Adherent Oil or Bitumen from Rock.

ROYAL GEOGRAPHICAL SOCIETY (at Æolian Hall), at 8.30.—G. M. Gathorne-Hardy: A Recent Journey in Northern Labrador.

ROYAL SOCIETY OF MEDICINE (Tropical Diseases and Parasitology Section), at 8.30.—Dr. Broughton-Alcock, Prof. W. Yorke, and Dr. P. Manson-Bahr: Discussion: Amœbic Dysentery in Great Britain: its Significance and Treatment.—Dr. M. Khalil: Thermotropism in Ankylostome Larvæ.

TUESDAY, DECEMBER 6.

ROYAL SOCIETY OF ARTS (Dominions and Colonies Section), at 4.30.—F. C. Wade: British Columbia: The Awakening of the Pacific.

ROYAL SOCIETY OF MEDICINE (Surgery: Sub-Section of Orthopædics), at 5.30.—N. Dunn and others: Discussion: Stabilising Operations in the Treatment of Paralytic Deformities of the Foot.

WOMEN'S ENGINEERING SOCIETY (at 26 George Street, W.1), at 6.15.—T. Clarkson: The Use of Home-produced Fuels for Commercial Motor Transport.

INSTITUTE OF MARINE ENGINEERS (at 85 The Minories), at 6.30.—Sir D. Wilson-Barker: Weather at Sea, including Clouds, Waves, etc.

ROYAL PHOTOGRAPHIC SOCIETY OF GREAT BRITAIN, at 7.—H. M. Edmonds: A New Mode of Producing Sculptures by the Aid of Photography.

RÖNTGEN SOCIETY (at Institution of Electrical Engineers), at 8.15.—M. A. Codd: Some Investigations on Transformer-Rectifier Sets for X-rays.—C. E. S. Phillips: X-ray Tubes Connected in Parallel.

ROYAL SOCIETY OF MEDICINE (Pathology Section) (at Lister Institute), at 8.30.—Dr. V. Korencheusky: Experimental Rickets in Rats, with Demonstration of Specimens.—Dr. G. Ségal: The Association of Typhus Virus with the Various Blood Elements.—A. W. Bacot: Demonstrations of Rectal Infection of Lice by Weigl's Method.—A. W. Bacot and Dr. G. Ségal: The Development of Rickettsia in Lice, following Intrarectal Infection with Typhus Virus.—Dr. R. St. John Brooks and Dr. M. Rhodes: Some Observations on the Hæmorrhagic Septicæmia Group.—Miss E. H. Lepper: Gall-bladder Infections following the Intravenous Inoculation of Coliform Organisms in Rabbits.—Dr. S. P. Bedson:

Demonstration of Histological Material from Experimental Purpura.—Dr. S. Kanai: Dysentery Immunisation per Os.

WEDNESDAY, DECEMBER 7.

ROYAL BOTANIC SOCIETY OF LONDON, at 3.—Prof. A. W. Bickerton: Gardening (2).

ROYAL INSTITUTE OF PUBLIC HEALTH, at 4.—Sir Kenneth Goadby: Lead-poisoning in Industry.

GEOLOGICAL SOCIETY OF LONDON, at 5.30.—S. S. Buckman and J. F. Jackson: Jurassic Chronology. II. Preliminary Studies. A. Certain Jurassic Strata near Eypemount (Dorset). Part I. The Junction Bed of Watton Cliff and Associated Rocks.—J. Stansfield: Banded Precipitates of Vivianite in a Saskatchewan Fireclay.

ROYAL SOCIETY OF MEDICINE (Surgery Section), at 5.30.—Sir Charles Ballance: Ligation of the Innominate Artery.—Sir Lenthal Cheatle: A New Operation for Inguinal Hernia.

INSTITUTION OF ELECTRICAL ENGINEERS (Wireless Section), at 6.—T. L. Eckersley: An Investigation of Transmitting Aerial Resistances.

INSTITUTION OF RAILWAY SIGNAL ENGINEERS (at Midland Grand Hotel), at 6.—Resumed Discussion on Paper by A. E. Tattersall: Three-position Signalling.

INSTITUTION OF SANITARY ENGINEERS (at Caxton Hall), at 7.—S. A. Hill-Willis: Town Planning.

ROYAL MICROSCOPICAL SOCIETY (Biological Section), at 7.30.

ENTOMOLOGICAL SOCIETY OF LONDON, at 8.

ROYAL SOCIETY OF ARTS, at 8.—E. Cammaerts: Literature and International Relations.

SOCIETY OF PUBLIC ANALYSTS (at Chemical Society), at 8.—B. S. Evans: The Estimation of Small Quantities of Antimony in Copper and Brass.—A. Lucas: The Inks of Ancient and Modern Egypt.—C. L. Claremont: Notes on the Analysis and Use of Red Squill in Rat Poisons.

ROYAL SOCIETY OF MEDICINE (Neurology Section) (at Hospital for Paralysis, Maida Vale), at 8.30.—Clinical Meeting.

ROYAL SOCIETY OF MEDICINE, at 9.—Sir Berkeley Moynihan: Medicine in Art.

THURSDAY, DECEMBER 8.

ROYAL SOCIETY, at 4.30.—*Probable Papers.*—Lord Rayleigh: A Study of the Glow of Phosphorus: Periodic Luminosity and Action of Inhibiting Substances (with Experimental Demonstration).—Lord Rayleigh: The Aurora Line in the Spectrum of the Night Sky.—W. D. Womersley: The Energy in Air, Steam, and Carbon Dioxide from 100° C. to 2000° C.—Lt.-Col. J. W. Gifford: Atmospheric Pressure and Refractive Indices, with a Corresponding Table of Indices of Optical Glass.—H. P. Waran: A New Form of Interferometer.—H. Harle: On the Viscosities of the Hydrogen Halides.

ROYAL COLLEGE OF SURGEONS OF ENGLAND, at 5.—Sir Charles Ballance: A Glimpse into the History of the Surgery of the Brain (Thomas Vicary Lecture).

ROYAL SOCIETY OF MEDICINE (Balneology and Climatology Section), at 5.30.—Dr. A. G. S. Mahomed: The Relation of Atmospheric Electrical Variations to the Incidence of Epileptic Fits.—Discussion on the Organisation of the Section.

OPTICAL SOCIETY (at Imperial College of Science and Technology), at 7.30.—L. C. Martin: The Physical Meaning of Spherical Aberration.—Dr. F. Lloyd Hopwood: An Auto-stroboscope and an Incandescent Colour Top.—Lt.-Col. Gifford: Achromatic One Radius Doublet Eyepieces.

CHEMICAL SOCIETY (at Institution of Mechanical Engineers), at 8.—Prof. J. W. Gregory: The Genesis of Ores.

INSTITUTE OF METALS (London Section) (at 85 The Minories), at 8.—S. A. E. Wells: Casting in Metal Moulds.

HARVEIAN SOCIETY (at Medical Society of London), at 8.30.—Sir John Charlton Briscoe, Bart., Sir Sidney Russell Wells, Dr. G. H. Hunt, and Sir William Willcox: Discussion: Is the Anginal Syndrome only of Cardiac Origin?

FRIDAY, DECEMBER 9.

ASSOCIATION OF ECONOMIC BIOLOGISTS (in Botanical Lecture Theatre, Imperial College of Science and Technology), at 2.30.—Prof. J. H. Priestley and others: Discussion: The Resistance of the Normal and Injured Plant Surface to the Entry of Pathogenic Organisms.

ROYAL ASTRONOMICAL SOCIETY, at 5.

PHYSICAL SOCIETY OF LONDON (at Imperial College of Science and Technology), at 5.—G. A. Sutherland and L. Clark: The Average Range of -rays in Different Metals.—Prof. E. Wilson: The Sensitivity of Ballistic Galvanometers.—Prof. R. Ll. Jones: The Determination of the Damping Decrement of a Tuning Fork.—Dr. E. A. Owen: The Estimation of the Radium Content of Radio-active Luminous Compounds.

ROYAL SOCIETY OF MEDICINE (Clinical Section), at 5.30.

INSTITUTION OF MECHANICAL ENGINEERS (Informal Meeting), at 7.—Continuation of Discussion on Ball and Roller Bearings: Some Recent Types and Criticisms.

ROYAL SOCIETY OF MEDICINE (Electro-therapeutics Section), at 8.30.—Dr. Carelli: Demonstration of his Method of Radioscopic Examination with the Help of Gas Injections.—Dr. Riddell: Demonstration of a Simple Apparatus for Making Serial Radiographs of Pyloric Region in the Horizontal and Upright Positions.

ROYAL SOCIETY OF MEDICINE (Ophthalmology Section), at 8.30.—Clinical Evening.

PUBLIC LECTURES.

(A number in brackets indicates the number of a lecture in a series.)

THURSDAY, DECEMBER 1.

UNIVERSITY COLLEGE, at 5.—Prof. J. E. G. De Montmorency: Feudalism in Western China and in Africa (5).

IMPERIAL COLLEGE OF SCIENCE AND TECHNOLOGY, at 5.30.—W. Bateson: Recent Advances in Genetics (5).

FRIDAY, DECEMBER 2.

UNIVERSITY COLLEGE, at 4.30.—Dr. J. C. Drummond: Nutrition (8).

IMPERIAL COLLEGE OF SCIENCE AND TECHNOLOGY, at 5.30.—Dr. J. D. Falconer: The Wonders of Geology (Swiney Lectures) (12).

UNIVERSITY COLLEGE, at 8.—Prof. G. Dawes Hicks: Our Knowledge of the Real World (5).

MONDAY, DECEMBER 5.

UNIVERSITY COLLEGE, at 5.30.—Prof. A. Wolf: The Literature of Science.

KING'S COLLEGE, at 5.30.—Dr. W. R. Ormandy: Liquid Fuel Engines (4).

TUESDAY, DECEMBER 6.

KING'S COLLEGE, at 5.30.—Prof. H. Wildon Carr: The Modern Scientific Revolution and its Meaning for Philosophy (9).—Dr. W. Brown: Psychology and Psycho-therapy (8).

WEDNESDAY, DECEMBER 7.

SCHOOL OF ORIENTAL STUDIES, at 12.—Miss Alice Werner: Bantu Tribes of East Africa (5). At 5.—Dr. T. G. Bailey: The Sansis, or Thieves of India: their Language, History, and Customs.

UNIVERSITY COLLEGE, at 5.—Prof. G. Elliot Smith: The Evolution of Man (3).

THURSDAY, DECEMBER 8.

UNIVERSITY COLLEGE, at 5.—Prof. J. E. G. De Montmorency: Feudal Vestiges in America and Elsewhere (6).

IMPERIAL COLLEGE OF SCIENCE AND TECHNOLOGY, at 5.30.—W. Bateson: Recent Advances in Genetics (6).

KING'S COLLEGE, at 5.30.—H. W. Fitz-Simons: Bridge Construction (5).

BARNES HALL (1 Wimpole Street, W.1), at 8.—Dr. C. Singer: The History of the Doctrine of Infection (Chadwick Lecture).

FRIDAY, DECEMBER 9.

UNIVERSITY COLLEGE, at 8.—Prof. G. Dawes Hicks: Our Knowledge of the Real World (6).

SATURDAY, DECEMBER 10.

IMPERIAL COLLEGE OF SCIENCE AND TECHNOLOGY, at 10.30 a.m.—Prof. W. W. Watts: Geology as a Basis for Geography (Lectures for Teachers).

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