NATURE

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"To the solid ground
Of Nature trusts the mind which builds for aye."—WORDSWORTH.

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For other Official Advertisements see pages lii and liii.

SOUTH AFRICAN SCHOOL OF MINES AND TECHNOLOGY, JOHANNESBURG

(UNIVERSITY OF SOUTH AFRICA).

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CHALMERS, GUTHRIE & CO., LIMITED,
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Applications for the post must be forwarded to him not later than October 15, 1919.

The Council does not necessarily limit itself in its choice to names sent in in response to this advertisement.

J. H. DAVIES, Registrar.

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E. SALTER DAVIES,
Director of Education.

September 25, 1919.

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CHEMISTRY MASTER, to be responsible for the subject throughout the School.

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Applications, with copies of testimonials of recent date, to be sent at once to F. C. SMITHARD, Education Office, Beckett Street, Derby.

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SCIENCE MISTRESS WANTED, as soon as possible or January, to take Physics and possibly some Chemistry in "advanced course" recognised by the Board of Education, and to assist in the general Science work of the school. Good Honours Degree and some experience essential. Salary according to qualifications and experience.—Apply, with full particulars and testimonials, to HEAD MISTRESS.

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Applications are invited, from ex-Service men only, for the post of ASSISTANT ENTOMOLOGIST to the Board. Salary £300–£500, plus war bonus.

Applications by letter, accompanied by a short statement of experience and two testimonials, should reach the SECRETARY, Board of Agriculture and Fisheries, 4 Whitehall Place, S.W.1, not later than Monday, October 6.

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Applications are invited for the position of PROFESSOR of ECONOMICS at the above University, at a salary of £800 per annum. Full particulars and forms of application obtainable by sending stamped addressed foolscap envelope to the HIGH COMMISSIONER FOR NEW ZEALAND, 415 Strand, London, W.C. 2, by whom complete applications will be received up to November 1 next.

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Applications are invited for the post of ASSISTANT LECTURER in MATHEMATICS. Salary £300. Apply immediately, giving details of University career and teaching experience (if any), together with names of references, to the SECRETARY, University, Leeds.

GOVERNMENT LABORATORY, TEMPORARY CHEMICAL ASSISTANTS required. Salary £160-£10-£220. War bonus, Men from £92; Women from £72.—Apply with copies of testimonials, GOVERNMENT CHEMIST, Clement's Inn Passage, W.C.2

LABORATORY ASSISTANT (Technician), demobilised, requires post. 12 years' experience, General Bacteriology, specialised in Intestinal and Wassermann work, aptitude for research.—Apply Box 248, c/o NATURE Office.

For other Official Advertisements see pages l *and* liii.

"NATURE," last 76 vols., £9; "The OBSERVATORY," last 37 vols., £7; "Astronomical Journal," XIX–XXX inclusive, £4; "Astron. Nachr.," 130 vols., £30.—Box 250, c/o NATURE Office.

CHEMICAL BALANCE by OERTLING. 12 in. beam platinum scale hangers, with gramme weights and sp. gr. bottle. 15 gns. or offers, seen by appointment—FREEMAN, Otford.

THURSDAY, OCTOBER 2, 1919.

THE WASTE OF YOUTH.

Problems of National Education. By Twelve Scottish Educationists. With Prefatory Note by the Right Hon. Robert Munro. Edited by John Clarke. Pp. xxvi+368. (London: Macmillan and Co., Ltd., 1919.) Price 12s. net.

THE extension of the school age from fourteen to fifteen, with compulsory education in continuation classes to eighteen years of age, which is the main provision of recent educational legislation, adds four additional years of schooling at the most critical and formative period of life. It is to be hoped rather than expected that better use may be made in the future than has been made in this country of the school period in the past. One opens this book on "Problems of National Education," a collection of twelve essays by Scottish educationists, expecting some assurance at least that the stale old stock-in-trade of the schoolmaster derived from the Middle Ages had, in public education at least, been finally discredited. Then Latin was the universal written language, and it has been handed on as a ready-made means of disciplining youth to distasteful tasks, after all intelligible reason has ceased and the manifold activities of a rapidly expanding and luxuriant scientific civilisation have made it unsuitable. But, alas! in education the vicious circle besets one at every turn. It is idle to expect the child to be put *au fait* with the modern world, of which already he probably knows far more in certain ways than his teachers, until the latter have caught up with it and the subjects of their training in the ancient universities and the training institutions been fundamentally recast. But in this book every and any aspect of education is discussed exhaustively rather than this central problem.

The work of building up more and more elaborate superstructures on such false foundations meanwhile goes merrily on. Physical training, ethical, moral, religious, æsthetic, and civic education, anything rather than the intellectual foundations, are all explored in these centrifugal essays by experts in the vain hope of disguising the rottenness of the core. For, excellent and informative as are many of these discussions on the outriders and secondary consequences of national education, on the main theme, which is engaging the attention of the taught, if not the teachers, this volume is singularly vacuous.

Thus we read: "The new movement regards the purpose of education as primarily social efficiency and social progress rather than individual development and personal success," followed by the inevitable reference to Plato and Aristotle, which with unconscious and monotonous irony reiterates the fatal retrospective habit of mind. The future, if it learns from the past, will see to it that this type is put in charge of museums and cemeteries rather than of the growing child.

The main primary, as it was the original, purpose of the school is still to provide the child with a suitable intellectual equipment with which to face the world of the twentieth century. That is the weak spot, and it does not solve the problem to pretend that intellectual efficiency is Prussian and therefore to be shunned, or that preparation for the world of to-day is vocational and therefore no proper part of school work.

Principal Laurie contributes the most valuable and satisfying exposition of the position in his essay on "Technical Education." His statement—"To deal with the promotion of scientific research, I draw no distinction between pure and applied science, as no distinction can be drawn in practice. The first essential is the pursuit of science for its own sake as a pure branch of knowledge" (p. 249)—may be generalised. With regard to intellectual training, no distinction can be drawn between cultural and vocational training. The first essential is that the intellect must be trained for its own sake. The culture of a workman is the vocation of a scholar, and *vice versa*, though the scholar might not be sufficiently cultured to admit it. The educationist surely should use every means most calculated to develop the growing intelligence of a child and not scorn the new because they are, or may be, vocational.

Another remark from this essayist needs no comment:—"The love of knowledge for the sake of knowledge, which inspired the Greek civilisation, is not understood by the very men who have received a classical education. They do not see that the man of science is carrying on the tradition of Greek culture to-day."

As an example of how completely cut of touch a teacher may be with the psychology of modern youth, a passage from the essay on "Moral and Religious Elements in the School" may be quoted (p. 148):—"There seems to be no good reason why the narratives of the miracles in the Old Testament should be excluded. The wonderful and the miraculous are a source of great delight to young children and may be turned to good moral purpose. Provided that at some stage in the pupils' school career they are exhibited in their proper light, there is no reason to debar children from reading and enjoying these narratives." Possibly this may throw some light on the complaint (p. 110): "Little or no respect or consideration for older people is exacted from the young. It is not easy to detect in them the spirit of reverence either for institutions or individuals."

Classical education, according to Prof. Burnet, is about to achieve fresh laurels in the new era. "Humanity" its exponents call it—"that is to say, the literature, institutions, and thought of antiquity," thereby subtly suggesting that modern man is not humane, or humane by descent rather than by ascent, in conformity with the ancient, exploded Biblical myth, so harking ever backwards to the past rather than reaching out towards and apprehending the more glorious future.

"Now the first thing," he says (pp. 183–85), "we have to realise is that we are witnessing the dawn of a renaissance of humanism in Europe comparable only to that of the fifteenth century or to the magnificent expansion of science in the nineteenth. . . . Excavation, especially in Crete, and the recovery of papyri from the sands of Egypt have not only transformed our outlook upon the Mediterranean civilisation, of which our own is the lineal descendant, but has given us the inspiring feeling that some new truth of first-rate importance may come to light any day. . . . It is becoming plain that what we call science may be best described as *thinking about the world in the Greek way*." (Dr. Laurie's way of putting this has already been quoted.) "But there is another, and perhaps a deeper, reason for believing that a humanist renaissance is at hand . . . In the hard times ahead of us the greater number will turn rather to the poets, historians, and philosophers for solace and edification than to the austerer discipline of the exact sciences. That is for the few; the mass of men can hardly penetrate beyond its outer courts."

So, the classics are still for the many and science for the few! Nothing is incredible, not even that this and much more like it should actually be written as a contribution to "Problems of National Education" at the close of the great war. If these are the people to whom their children's educational destinies are to be committed for four further years, the Labour Party will do well to expedite its attainment of a minimum State subsistence. For, be they turned out from school with their physique, morals, and manners, religious and æsthetic perceptions, civic ideals, and use of the subjunctive mood in subordinate clauses in the ancient languages never so perfect, it is difficult to see what else can save them from starvation in the hard times ahead. Until something more in keeping with the age is substituted for the intellectual training of the school, the words in the opening essay (p. 39) will continue to be true: "They begin their course with keen interest and lively curiosity. Then shades of the prison-house seem gradually to close upon the growing boy."

FREDERICK SODDY.

BIOLOGICAL PROBLEMS.

Life and its Maintenance: A Symposium on Biological Problems of the Day. Pp. viii+297. (London: Blackie and Son, Ltd., 1919.) Price 5*s*. net.

DESIRE, want, pain, disease, and death, the tools used by Nature for fashioning the race, are equally efficacious for awakening the mental and bodily faculties of the individual. Under their goad the soldier has not only shown himself gifted with an unsuspected degree of intelligence, but, what is more important, has discovered how to use the intelligence of others, so that at the close of the war our scientific arms, creations of the war itself, were more efficient than the corresponding formations in the Army of a nation which had long prided itself on its thorough utilisation of all the means science placed at its disposal. Even among those compelled by age or infirmity to carry on their normal vocations at home, the trifling discomforts and privations to which they were subjected under war's constraints acted as hormones, as adequate stimuli for arousing their slumbering mental faculties, and disturbing for a while the hopeless incuria with which, to the detriment of the body politic, our upper and middle classes are afflicted. Any discomfort, whether it be the presence of a flea or the necessity of absorbing war bread, rouses an appropriate reaction and interest in its removal. Thus it came about that a sufficient number of persons, anxious to devote a certain time to learning about the world around them with special reference to the discomforts under which they were suffering, and willing to devote an hour in the week to this purpose, were found to justify the delivery at University College of a course of lectures which are reproduced in this volume under the general title of "Life and its Maintenance."

The first object of interest to every man is himself, and since at the time of the delivery of these lectures there was a certain amount of food shortage and a reasonable doubt as to the prospects of food supplies in the future, it is natural that most of these lectures are devoted to the subject of food, its effects on man, and the methods of increasing its production in this country.

Prof. Bayliss leads off with a clear, elementary account of the significance of food for the body. This is followed by a reassuring lecture on war bread by Prof. Hopkins. The third lecture, by Miss Hume, deals with accessory food factors, the importance of which was brought into unwelcome prominence by the outbreaks of beri-beri and scurvy among our forces abroad, and the consideration of which, in their relation to infant feeding, must always take an important place in our measures for ensuring the health of the community. Prof. Cushny contributes a judicious and well-balanced lecture on the subject of alcohol, and the various questions relating to the production of food by the improvements of farming methods are dealt with by Dr. Russell, Mr. Stapledon, Dr. Horne, and Profs. Hickson and Tansley.

The last five lectures are of a more miscellaneous import. The shortage of paper prompts Prof. Oliver, who was responsible for editing the whole series, to give a useful summary of the various materials used in the manufacture of paper and to describe certain new plants, notably a grass (*Spartina Townsendii*) growing on the mud flats of Southampton Water, which had been tried for this purpose. Dr. Vernon deals with the relations of industrial efficiency and fatigue. This subject is so closely connected with the question of hours of labour that no one possessed of a vote has a right to say that it does not concern him. This lecture, as indeed the whole collection, is an attempt to rouse the man in the street to take an interest and a part in the search for such knowledge and methods as by their generalisation may increase the efficiency and thereby the prosperity of the nation as a whole. The next few years will be marked by the introduction of one legislative measure after another directed to this end, but probably in many cases ill-conceived from lack of acquaintance among law-givers and people with the intimate character of the problems involved. To those problems which affect the life of the individual this series of lectures will serve as an interesting and authoritative introduction.

SOUTH AUSTRALIAN GEOLOGY.

The Geology of South Australia. (In two divisions.) Division 1, *An Introduction to Geology, Physiographical and Structural, from the Australian Standpoint.* Division 2, *The Geology of South Australia, with Notes on the Chief Geological Systems and Occurrences in the other Australian States.* By Walter Howchin. Pp. xvi+543. (Adelaide: The Education Department, 1918.) Price 10*s.*

FOLLOWING the example of Mr. Chapman's Australian fossils—an outline of palæontology based on Australian examples for Australian students—Mr. Howchin, of the University of Adelaide, has prepared a general text-book of geology based on Australian illustrations, followed by an account of the geology of South Australia, with shorter summaries of that of the other Australian States. The book should be very useful, as it fills a gap in Australian educational literature, while it supplies geologists in general with an excellent and up-to-date compendium of the geology of South Australia. Mr. Howchin is exceptionally qualified for the work; he is well known for his discovery of the Australian Cambrian glacial deposits, his researches on fossil foraminifera, and his text-book on the geography of South Australia. The first division of the work gives a clear summary of the general outlines of geology; it is especially good in the physiographic portions. The petrology is comparatively elementary, since the book, being published by the South Australian Education Department, is probably intended more for secondary schools than for university students. Australian petrologists may consider that there is inadequate notice of the alkaline igneous rocks; and in an effort at simplification "pyroxene (augite)" is included in the hornblende group, a step which would lead students to overlook the important distinction between the pyroxenes and the amphiboles. The parallelism of these series is also not indicated in the statement as to the composition of augite. There is not much information about economic geology; for example, the author tells us nothing about the oil-fields of South Australia and their prospects. He follows those who extend the petrographic use of the word "mineral" for mineral species into general geology, although mineralogists, such as Miers, adopt the more commonsense practice which does not refuse the term "mineral" to most economic minerals. The author, of course, cannot be consistent, for the term is not used in the latter part of the book in accordance with the restricted definition. In regard to the Australian artesian water, the author adduces evidence that the supply is dwindling from the reduction in size of the mound springs; but those who hold that plutonic water is largely influential in the uplift of the water in the wells do not consider, as is twice stated, that most of the water is plutonic in origin.

Mr. Howchin makes the interesting suggestion that the word "scree," of which the etymology is doubtful, comes from "screed," a fragment; but is it not more probably from "screen," owing to the resemblance to the sloping sheet of angular fragments on a road metal screen? The most important chapter is that on the Lower Cambrian glacial deposits, which extend northward from Adelaide for about 450 miles to a latitude as low as 29½. The author, to whom is due most of the existing knowledge of these beds, shows that they were probably laid down at sea-level. The occurrence of this great sheet of subtropical low-level glacial deposits at the very beginning of the fossiliferous rocks is one of the most significant facts in geological history. Mr. Howchin also tells us the latest information from the trans-continental railway bores as to the extension into Australia of the Cretaceous sea, and shows that in all probability it did not extend across the continent. The book is illustrated by numerous well-selected and excellent illustrations.

J. W. G.

OUR BOOKSHELF.

Annual Reports on the Progress of Chemistry for 1918, issued by the Chemical Society. Vol. xv. Pp. ix+240. (London: Gurney and Jackson, 1919.) Price 4*s.* 6*d.* net.

THESE important volumes have been issued annually by the Chemical Society since 1905. Their object is to present an epitome of the principal definite steps in advance which have been accomplished in the preceding year for the benefit of workers or students in pure or applied science. They are not popular in any sense of the word. During the war there was necessarily some slackening in the production of results bearing chiefly on purely scientific problems, and the volume for 1918 is somewhat thinner than the volumes issued in previous years. Nevertheless, some advances can be recorded. For very many years the mass of the atom has been regarded as determining its chief properties. This is embodied in Mendeléeff's periodic scheme familiar to every chemist. It is therefore not surprising to find that the new doctrine which assumes some knowledge of the internal constitution of the atom should be rather slowly accepted. But chemical physics or physical chemistry is a department of knowledge which is undergoing rather rapid and bewildering change consequent on advances in positive knowledge. Absorption spectra, the properties of colloids, ionisation and the nature of ions, the nature and source of osmotic pressure, and the relations of isotopes are all subjects of supreme interest, many of which have assumed a totally new form, or have even been recognised only within the last twenty years. The chemical student of the future will need to be a fairly good mathematician if he hopes to follow all that is going on in these several directions. Fortunately there are other large fields of work still open in which this is not an essential condition and where great successes continue to be scored, especially in constitutional and synthetic organic chemistry and its applications to problems in physiology, animal and vegetable. These are all dealt with under appropriate heads in this volume of reports.

Heredity. By Prof. J. Arthur Thomson. Third edition. (The Progressive Science Series.) Pp. xvi+627. (London: John Murray, 1919.) Price 15*s*. net.

THE first edition of Prof. Thomson's "Heredity," which appeared in 1908, was reviewed at some length in NATURE (vol. lxxviii., pp. 361–63). The book quickly became established as an introduction—at once trustworthy, impartial, and comprehensive—to the many problems that are presented to students of inheritance, and a second edition with some additions and revisions was published in 1912. The third edition is now before us, and the author has taken the opportunity of directing the reader's attention to some of the important advances that have been made by investigators during the last seven years. The size of the book has not been increased from the second edition, so that room for additions has been found by condensing the type-setting on certain pages; this involves a brevity of treatment disappointing to those who would have valued Prof. Thomson's judicious criticism of several recent theories. For example, the studies by T. H. Morgan and his fellow-workers on the inheritance of linked factors in the fruit-flies (Drosophila), and W. E. Castle's work on the relation between heredity and selection in hooded rats, are barely mentioned.

A short list of some important books and papers of the last few years has been added to the bibliography, but the subject and general indexes appear to have escaped a revision which would have greatly increased their value. The paragraph on "Militarism" in the concluding chapter has been rewritten in the light of the experiences of the last five years, and the author emphasises Dr. Chalmers Mitchell's contention that "the struggle for existence as propounded by Charles Darwin and as it can be followed in Nature has no resemblance with human warfare." Again, as one turns the pages of Prof. Thomson's familiar volume, one realises how the study of biology, wisely applied, may become an aid rather than a rival to that of "the humanities." G. H. C.

LETTERS TO THE EDITOR.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can be 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.*]

A Photoelectric Theory of Colour Vision.

REFERRING to his letter under the above heading on p. 74 of NATURE of September 25, I perceive that Prof. Joly has had ideas similar to mine about an electric stimulation of the terminals of the optic nerve through bombardment of corpuscles flung off under the stimulus of ordinary light.

My argument is strengthened by reflecting that this utilisation of atomic energy, emitted in *quanta* under the stimulation of accumulated almost infinitesimal vibrations of the right frequency, can account for the extreme sensitiveness of the eye and of the sensitive pigments known very low down in the scale of animal life. The great variation of brightness permissible, between wide limits, without much differential physiological result is also natural on this view; so is the fatigue of colour-sensation by temporary exhaustion of a specific potentially radio-active material, until renewed by living tissue.

I should suppose that on this trigger-like basis the eye can form very little estimate of absolute brightness inside the limits above spoken of, though the ear, having no explosive mechanism, might be able to form a scale of loudness. In the main, photometric observations must be comparative.

A pathological condition of the retina, when flashes are perceived without objective stimulus, may be accounted for by overinstability of material and consequent spontaneous emission of corpuscles.

The experiments which Prof. Joly began to try seem to have been just in the general direction which I wished to encourage some young physiological physicist to pursue, only he must be prepared to design or adjust his electrical detecting instrument for extreme sensitiveness. A frog's nerve-muscle preparation could scarcely be responsive without something analogous to rods and cones, or something like an electric organ, and without access to unsheathed terminals. If a mechanical electroscope is employed it must have minute capacity; a silvered quartz filament, with a minimum of attachments, in the field of a microscope may be suggested.

OLIVER LODGE.

Reversed Pleochroic Haloes.

IN a paper on "The Genesis of Pleochroic Haloes" (Phil. Trans. R.S., vol. ccxvii.) by J. Joly, a theory is advanced accounting for certain structural features of the halo on the assumption that reversal of the halo-image is possible, and may take place under conditions defined in the paper. In support of this a drawing of a halo is given in which an evident inversion or change from positive to negative has occurred, the inner region being light, the outer dark.

Recently, in examining the brown mica extracted from a granite, we have found quite a large number of these negative haloes. All internal features are gone, solarised out of existence; the wide outer band alone remains. They resemble negatives of a much-exposed halo. Their dimensions shows that they possess uranium-charged nuclei. When the nucleus is *very* minute there is no sign of reversal; the halo is normal.

It is possible that the frequency of reversal in this mica is to be ascribed more to special uranium-richness of the nucleus rather than to the antiquity of the rock. The rock is a biotite granite with a white and a yellow felspar. It is said to be from Sinai. One side of the specimen has been exposed to the weather, and the appearance of this side suggests desert conditions.

J. JOLY.
J. H. J. POOLE.

Trinity College, Dublin.

The Spectra of Isotopes.

SOME years ago I made an investigation of the spectra of ordinary lead and lead from pitchblende residues, but I was not able to detect any difference in the spectra. More recently Aronberg (*Astrophys. Journal,* February, 1918) has found a difference in the wave-lengths of the principal line in the spectra of ordinary lead and lead from Australian carnotite amounting to 0·0043 Å. I have made a fuller investigation of the problem by a method of experiment greatly superior to that which I had previously adopted, and the results show that there is a small but real difference in the spectra, which agrees closely with the value found by Aronberg. A difference has also been found between the wave-length of the principal line in ordinary lead and lead from Ceylon thorite.

These results at once suggest that the spectroscope will furnish a simple and comparatively rapid method of distinguishing isotopes, and some measurements have been made of the wave-lengths of the principal line in ordinary thallium and in thallium from pitchblende residues. It has long been suspected that, in addition to lead, some of the metals found in pitchblende may be of radioactive origin, and the results of the wave-length measurements, though for certain reasons they cannot be given the same weight as those relating to lead, suggest that the thallium in pitchblende is an isotope of ordinary thallium and more probably of greater atomic weight. It is hoped to publish shortly an account of the investigation.

THOMAS R. MERTON.

Balliol College, Oxford, September 15.

A British Imperial Antarctic Expedition.

MAY I, through the columns of NATURE, direct attention to the British expedition which I am at present organising and propose to lead to the Antarctic in June next year? The objects of the expedition are briefly as follows:—

(1) To ascertain the position and extent of the mineral and other deposits of economic value already known to exist in Antarctica (*vide* scientific reports of Bruce, Mawson, Scott, and Shackleton), and obtain data for the practical development as a further source of Imperial wealth.

(2) To obtain further evidence of the localities of whales of economic value, and to create British industries in this trade.

(3) To investigate the meteorological and magnetic conditions in the Ross Sea area and at Cape Ann (Enderby Land) in connection with their influence under similar conditions in Australasia and South Africa respectively. That such results are of great economic value has been proved by the station established by the Argentine Government for similar purposes in the South Orkneys.

(4) To circumnavigate the Antarctic continent.

(5) Generally to extend our knowledge of Antarctica, especially with the view of obtaining further scientific data of economic importance.

The expedition proposes to leave England in June, 1920, and to be away for a period of five years. During this period important scientific research will be undertaken on the lines briefly given above. Applications are invited from fully qualified men in the following branches of scientific knowledge:—Geology, meteorology, biology, surgery and physiology, photography, cartography, and hydrography.

The expedition has been well and strongly supported, and I shall be glad if all who are interested will communicate with me at the address given below.

JOHN L. COPE.

66 Victoria Street, London, S.W.1,
September 20.

Luminous Worms.

WHEN I wrote the letter which appeared in NATURE of September 11 (p. 23), I made no reference to my impression that a friend had seen luminous earthworms in Great Britain because I was not aware that he was still in England, and was consequently unable to give accurate details. I found afterwards that this friend, Dr. Edgar Newbery, recently appointed professor of physical chemistry in the University of Cape Town, had not yet left this country, and I was able to write to him for confirmation of the impression in my mind, and I have now received a reply. Writing from Byton Rectory, Presteign, Radnor, Prof. Newbery says:—

"I have seen luminous earthworms on more than one occasion on the grass of our lawn here. (We are really in Herefordshire, though our post town is in Radnor). The soil from which they emerged is a mixture of clay and gravel, but is very fertile. The luminosity was very weak, and gathered in spots or blotches over the body. Small luminous patches were left behind on the grass in the track of the worm, but these faded in a very short time (30 seconds or so). I have seen them both in warm weather and when a slight frost was on the ground, but a very dark night is necessary to render them at all conspicuous, as the luminosity is so weak."

That Prof. Newbery is not confusing luminous earthworms with luminous centipedes is concluded from the next paragraph in his letter:—

"On Tuesday, September 2, I saw a remarkably brilliant luminous centipede in a barley field 100 yards from here. The light was so vivid that it caught my attention at a distance of 12 yards, and the luminous trail left behind it was quite 12 in. long. . . ."

Suggesting the cause of luminosity, Prof. Newbery says: —

"I am inclined to believe that the luminosity of these centipedes and worms is due to slow oxidation of some excretion from the body which may well be affected in quantity and quality by the food available."

So far as centipedes are concerned, I think Dr. Brade-Birks and I shall be able to show, in a forthcoming paper on luminous Chilopoda, that atmospheric oxygen is not necessary for the production of light in the centipedes we have studied, but Prof. Newbery's suggestion about food supply may explain why some individuals of a species are luminous while others are not.

In Verhoeff's "Chilopoda" (Bronn's "Klassen und Ordnungen des Thier-Reichs") there is no reference in the bibliography to Dr. T. L. Phipson's "Phosphorescence, or the Emission of Light by Minerals, Plants, and Animals" (London: Lovell Reeve, 1862); I therefore conclude that this useful work is little known. Phipson cites the experience of Audouin in 1814. In August that year some persons came to him at Choissy-le-Roi, near Paris, where he was on holiday, and told him they had seen an immense number of luminous earthworms in a chicory field not far away. These earthworms turned out to be centipedes. In another chapter Phipson tells us that in 1840 Forester wrote to the Academy of Sciences recording luminous earthworms. When this letter was communicated to the Academy, M. Audouin rose and said that he knew of no authentic case of luminous earthworms, but that he could cite numerous cases where luminous centipedes and worms had been confused. Whereupon Duméril, to prove that earthworms sometimes are phosphorescent, quoted the experience of Flaugergues and that of the naturalist Bruguière. It seems that M. Audouin was afterwards convinced of the fact that earthworms were sometimes luminous by the experience of Saigey and Moquin-Tandon, who found them so at Toulouse in 1837. Phipson quotes other evidence, and closes an interesting chapter with words which may confirm Prof. Newbery's suggestion about the relation between the quantity and quality of phosphorescence and the food supply:—

"I may add here," says Phipson, "that I distinctly remember witnessing, when quite a child, the phosphorescence of the earthworm; the light appeared connected with the slimy matter that covers the animal's body. It was whilst digging at night, in a large dunghill, for worms to supply baits for a fishing excursion that my schoolfellows and myself turned up many hundred Lumbrics in a highly luminous condition; but I cannot recollect in what month this happened."

S. GRAHAM BRADE-BIRKS.
16 Bank Street, Darwen, Lancashire,
September 13.

CATALYSIS IN CHEMICAL INDUSTRY.

THE catalytic agent is penetrating peacefully, yet effectively, into modern chemical industry. In explanation, to the lay mind, of the *rôle* of a catalyst in chemical reaction, comparison was recently cleverly drawn between the catalyst and the matrimonial agency. Both serve to bring together and to facilitate the union of others. Both are free after the consummation of the one process to renew their activities in like manner. The catalytic substance has played an important part in the many industries which have been necessary to the maintenance and equipment of the fighting Services with munitions of war. Not less distinctive a part has it played on the home front in the work of victory. The catalyst has been largely employed in the supply of margarine, to which we have grown accustomed. The soap with which we have been cleansed calls, in the process of its manufacture, for the assistance of the catalyst. The glucose which has helped to sweeten our lives, in time of a sugar shortage, is the resultant of yet another catalytic process.

Let us survey a few of the more striking applications of catalysis in industry. Glycerine for dynamite and nitroglycerine is obtained from fats by catalytic hydrolysis, using alkalis or acids as splitting agents. In the modern developments of fat-splitting the discovery of the Twitchell catalyst facilitated, owing to its combined acidic and fatty nature, the rapid working-up of low-grade fats and greases for glycerine and soaps. Sulphuric acid is made by one or other of two catalytic processes. The old or "lead chamber" process uses oxides of nitrogen to assist the process of oxidation of sulphur dioxide. For the stronger acid, the "oleum" or fuming sulphuric acid required in the nitration of toluene and phenol for high explosive, the modern "contact" process is more suitable. The sulphur dioxide and oxygen are caused to combine in the presence of solid contact agents such as platinum or oxide of iron. Chlorine, as well for poison-gas as for the more peaceful requirements of bleaching-powder of sanitation and water purification, is generated from hydrochloric acid by oxidation in the presence of copper chloride as catalyst. That very inert but plentiful constituent of the atmosphere, nitrogen, may now, with the assistance of a suitable catalyst, be caused to combine with hydrogen directly to form ammonia. This may be used for the production of ammonium sulphate for fertiliser, or oxidised in contact with a hot platinum gauze to form oxides of nitrogen, and thus lead to the manufacture of nitric acid or ammonium nitrate. The hydrogen which is necessary for ammonia synthesis is obtained most cheaply and effectively by another catalytic reaction, using water-gas and steam as the raw materials. Town gas and fuel gases generally are freed from obnoxious sulphur compounds present as impurities by catalytic processes of sulphur removal.

It is a matter of difficulty fully to characterise the developments which have attended in several instances the discovery of successful catalytic processes. Perhaps, however, an illustration involving the application of the researches of the brilliant French chemist, M. Paul Sabatier, will serve to demonstrate potentialities and possibilities inherent in academic research. M. Sabatier is the discoverer of the principle of catalytic hydrogenation, and has conducted an exhaustive series of researches into the phenomenon. The application of his results to industry has solved the century-old problem of the economic utilisation of liquid fats. During the last ten years, in ever-increasing measure, liquid fats and oils have been catalytically hydrogenated in presence of reduced nickel as catalyst to yield the more valuable hardened fats which are used in the soap and candle industry, as well as for purposes of food. The economic results of such application are tremendous. Whole tracts of tropical country are being opened up for the production of palm nut and other nut oils. Fish oils are being hardened and deodorised for use in the industry. New uses are being found for hardened cotton-seed, linseed, and similar largely available oils.

Catalytic hydrogenation has also been applied to the enrichment of gaseous fuels. The carbon monoxide of water-gas may be hydrogenated in presence of reduced nickel to give methane with consequent production of a gas of high calorific value and illuminating power. The production of hexahydro-benzol in bulk, by hydrogenation of benzene, is as yet in its infancy, but has a certain future owing to the utility of the product as a volatile fuel for internal-combustion engines. The fact that it is a single compound gives it marked advantages over petrol as a fuel for air transit, since the variability of petrol is a distinct drawback in the case of a fuel upon which such rigorous demands are necessary.

The development of the fine chemical industry in this country involves also an extended use of catalytic reactions. The successful production of synthetic indigo was facilitated by the discovery of the catalytic acceleration of the oxidation of naphthalene by mercuric sulphate, discovered owing to the breakage of a thermometer bulb in the reaction mixture. The production of dye intermediates involves, more and more, the aid of catalysis. Especially, however, in the large-scale preparation of solvents will catalysis contribute convincingly to success. Industrial alcohol may be cited in illustration. Every method by which this important solvent is produced is catalytic. The ordinary process of fermentation and distillation involves the participation of the living catalysts, the enzymes and ferments. The production of alcohol from potato and rice starch is a combined process of hydrolysis and fermentation with the catalytic action of acids followed by enzymes. Similarly, alcohol of the future will be obtained by catalytic degradation of the cellulose content of wood waste, or, synthetically, from acetylene and ethylene, by processes of catalytic hydration and hydrogenation. The potentialities of alcohol as a fuel in the future must not be forgotten, in view of the increasing consumption and prospective exhaustion of oil-fuel reserves. In the meantime these latter, as a result of more rigid scientific control, are being more economically utilised. The "cracking" of oils to yield the more volatile fractions usable in motor-engines is a modern development, the catalytic features of which have not, as yet, been completely realised.

From alcohol as starting-point, catalysis is involved in the production of acetic acid and acetone, the solvents largely required in the preparation of aeroplane dopes and varnishes. From methyl alcohol, a distillation product of wood, catalytic oxidation or dehydrogenation in presence of metallic copper yields formaldehyde, a powerful germicide and disinfectant, and itself the starting-point in the manufacture of bakelite, the artificial vulcanite or amber, a polymerised product formed under the influence of catalytic agents, and increasingly produced for use in electrical insulators and for fancy articles. The demand for formaldehyde is already so great that investigations are in progress with the object of production from sources other than methyl alcohol. The hydrocarbon methane has been suggested in this connection. A process of fractional oxidation of methane should yield formaldehyde. Alcohols and organic acids of varied complexity may be largely utilised in the production of synthetic essential oils and perfumes by processes of catalytic condensation.

The catalogue is not exhaustive, but sufficient has been said to show the paramount importance of catalysis in modern chemical industry. It is evident, therefore, that the modern curriculum of theoretical chemistry should concern itself largely with the scientific principles involved in catalytic reactions. An extended experience with catalysis, both pure and applied, has demonstrated that, from a complete realisation of the theoretical aspects of the problem, progress in the application follows the more rapidly and the more certainly. It is astonishing to note the facility with which new progress is attained by the employment of the scientific principles which have been acquired in a totally different application of catalysis to industrial progress. The records of certain of the Government Departments of investigative work, during the last few years, would be instructive in this regard. The need, therefore, is urgent for a well-trained force of young students, versed in the fundamentals of this modern branch of chemistry, and equipped to take their place in the further developments which lie so close at hand. There are manifold possibilities ahead—numerous processes and agencies catalytic awaiting the facile brain and hand of the investigator.

HUGH S. TAYLOR.

Frost protection

FROSTS AND AGRICULTURE IN THE UNITED STATES.

THE United States Department of Agriculture has recently issued a publication on "Frost and the Growing Season." This consists of a series of maps in colours and some diagrams from which the probable date of the last frost in spring and the earliest in autumn may be seen at a glance. An article on a paper by Mr. W. G. Reed on this subject appeared in the issue of NATURE for May 23, 1918, and the present publication is also by the same author.

Frosts are divided into three classes: "light," "heavy," and "killing." The first two terms apply to the amount of the deposit in the form of hoarfrost; the last only is dealt with in the paper, and is defined on an occasion on which the screen temperature fell below 32° F. In a country like the United States there is naturally great variation in the length of the period that is free from frost; not only is there variation in latitude from Florida to the Canadian border, but there is also much difference in the height above mean sea-level. The local topography is also important, for while, in general, frost is more prevalent at the greater altitudes, yet locally a small elevation will prevent a frost, and in enclosed valleys the hill-sides and the hill-tops may be less subject to frosts than the valley bottoms.

Frost records are available from about four thousand regular stations of the Weather Bureau, and of these about six hundred have a twenty years' record. The most noteworthy feature of the critical frost dates is their extreme irregularity. Thus at Peoria, Ill., with a fifty-nine years' record, the latest frost in spring covers a period of nearly fifty days, and the earliest in autumn a period of forty days. The maps are based upon the average dates.

The mountainous character of the country in the western portion of the United States, and the fact that the stations are mostly situated on the lower slopes of the mountains, make mapping very difficult, and it is pointed out that only a general idea of the conditions can be given. For practical purposes this position of the stations should not matter, as they would naturally be in those parts where cultivation was most prevalent.

It appears from the maps that there is no part of the United States except Key West where a frost may not occur, and the line showing a frost in half the years—that is, the line showing the position where a frost is just as likely to occur once in the winter as not to occur—excludes only a small part of Florida and reaches down to latitude 26° N. The line for the last frost before March 1 cuts off the peninsula of Florida and fringes the southern coast as far as New Orleans. In the north frosts are common until the middle of May or even June 1, and in the higher parts of the west, which are only used for grazing, they occur after June 1.

The earliest frost in autumn does not occur until after December 1 in Florida and in parts of the south-west. On the north-western frontier frost may be expected about the middle of September. About one-quarter to one-third of the whole country has a period of 210 consecutive days free from frost, but in the mountainous regions of the west there is a good deal of country in which the period is barely half as long.

Some smaller maps give information as to the frequency of frosts in the different districts one, two, or more weeks before or after the average dates. The whole paper is most interesting, and should be very useful to agriculturists in the United States.

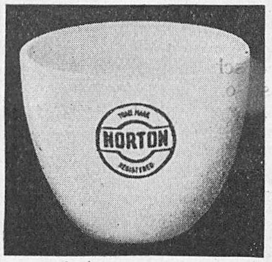
W. H. D.

NOTES.

THERE was a certain inevitableness in the nomination of Mr. Arthur James Balfour for the Chancellorship of Cambridge University. The fact that Mr. Balfour has consented to be so nominated in succession to his late brother-in-law has everywhere been received with enthusiasm. In the history of Cambridge, statesmen, administrators, literary men, and philosophers have succeeded one after another in the roll of Chancellors, but in Mr. Balfour, the most celebrated of living graduates of Cambridge University, all are combined in one man. Mr. Balfour is one of the two honorary fellows of Trinity College, the other being the Right Hon. G. O. Trevelyan. Mr. Balfour was educated at Eton, and entered Trinity College in the late 'sixties. He took his degree in the Moral Sciences Tripos of 1896, in the same year as Dr. Percy Gardner, now the professor of archæology at Oxford. The Balfour family has been most intimately associated with Cambridge; his younger brother Francis, who unhappily perished in the Alps in 1882, was a man of the highest scientific distinction, one who was leading zoologists along new lines of thought; another brother, Gerald, was a fellow of Trinity; one of his sisters married Prof. Henry Sidgwick, and was for many years Principal of Newnham College; and another sister married Lord Rayleigh, whose recent death has deprived the University of a generous Chancellor and a great pioneer in modern physics. A reference to "Who's Who" will show not only the list of honorary degrees, too long to be quoted here, which have been conferred upon Mr. Balfour, but also that he has constantly taken the lead on various boards and committees connected with education. He has been Lord Rector of St. Andrews University, Lord Rector of Glasgow University, and he is Chancellor of Edinburgh University. The announcement that so distinguished a man and scholar has consented to be nominated for the post of Chancellor has met with widespread sympathy and hope amongst the members of the Senate.

ENTOMOLOGISTS, it appears, have not yet solved the problem of what becomes of the house-fly in wintertime. The popular idea that when the cold season comes the house-flies, or such of them as do not die off, retire to some quiet nook or cranny in the house and, like dormice, sleep undisturbed through the winter is still entertained in some scientific and other respectable quarters, although no trustworthy evidence has been found to support it. There are flies and flies; and, as Dr. L. O. Howard was, we believe, the first to suggest, no evidence relating to the hibernation of the house-fly can be trusted until it has first been submitted to expert examination. Since that suggestion was made, a large amount of evidence has been submitted to experts, and now they are almost unanimously agreed that the hibernating house-fly is a wholly mythical creature. But the house-fly must get through the winter somehow, and if not in its perfect state as a fly, then in some other stage or stages of its life, or else we should not be troubled with the pestilent brood year after year in succession. Before the entomologist can tell us exactly how, it looks as if he will need the help of the sanitary officer, the stable-boy, the farm labourer, or even of the Boy Scout, rather than that of the ordinary householder. The search for larvæ and pupæ of the fly is not an easy one, and often involves a great amount of physical labour. In summer-time the pupæ are frequently to be found living at a depth of 2 ft. under the surface of the soil within half a yard of a manure heap. Dr. Gordon Hewitt has searched for them in such places, and in every other likely place, in wintertime, and has never succeeded in finding any alive. But because he, and possibly a few others, have made it and failed, it can scarcely be said that a search of that kind has been exhausted, and that we must fall back upon the hibernating adult fly as the only alternative. There may be no definite hibernating stage in the life of the fly. The insect may continue to breed in the winter, not exactly as it does in the summer or autumn, but at a greatly retarded rate, each stage being more or less prolonged. This probably does not happen to any extent under natural conditions in this country, but the number of places in which it can happen, and probably does happen, under special conditions may be quite sufficient to account for the perpetuation of the fly.

THE officers and other members of council of the Röntgen Society for the session 1919–20 are as follows:—*Pesident:* Dr. Sidney Russ. *Hon. Secretaries:* Dr. Robert Knox and Dr. R. W. A. Salmond. *Hon. Treasurer:* Mr. Geoffrey Pearce. *Hon.*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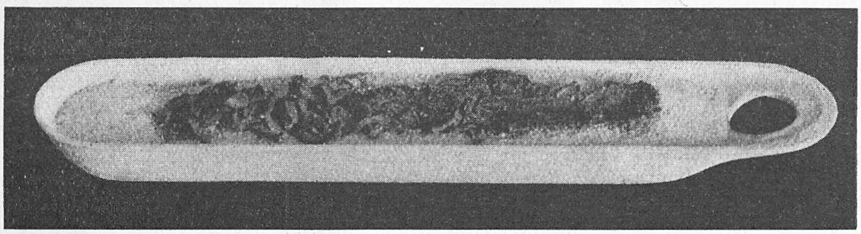


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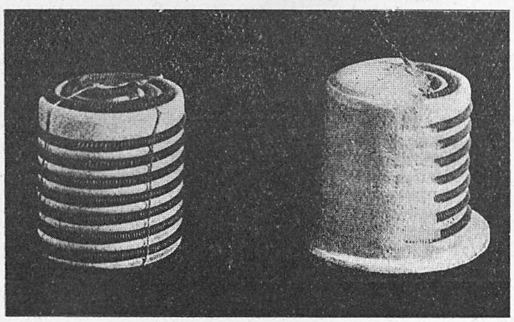

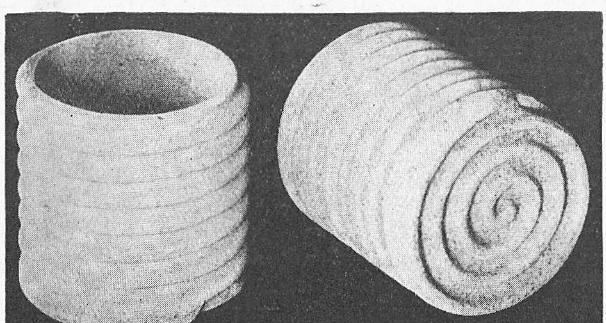

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A CONGRESS attended by 350 persons met at Marseilles in January last, under the auspices of the local Chamber of Commerce, to discuss and emphasise the rights of France over Syria. The discussions of the congress were divided into four sections :—Economics, archæology and history, education, and medicine and hygiene. A summary of the main papers of geographical interest is given in *La Géographie* (vol. xxxii., No. 5). M. E. de Marbonne contributed a paper on the geographical unity of Syria, in which he showed that Syria cannot be divided latitudinally, but that the natural divisions of the country extend from north to south, and are separated approximately by meridians from the Mediterranean to the valley of the Euphrates. Various papers of considerable value, although from a distinctive point of view, dealt with the trade and ports of Syria.

AT the instigation of the Admiralty, the Royal Geographical Society has taken steps to form a permanent committee on geographical names, on which the Admiralty, War Office, Foreign Office, Colonial Office, India Office, Post Office, Board of Trade, Board of Agriculture, and the Royal Geographical Society are represented The chairman of the Committee is Major-Gen. Lord Edward Gleichen, and Mr. A. R. Hinks is acting povisionally as secretary. The Committee hopes eventually to examine all cases of doubtful nomenclature and spelling in the place-names of the British Empire, accepting, wherever possible, official name-lists such as those provided by the Gazetteer of India, the Board of Geographic names of Canada, etc. Place-names of the British Isles are outside the scope of the Committee, as they are dealt with by the Ordnance Survey. Lists of names will be published at intervals after they have been submitted for approval to the authorities of the country concerned. Correspondence regarding confused or doubtful place-names of which the writer has personal knowledge is invited, and should be addressed to the Secretary, Committee on Place-Names, c/o Royal Geographical Society, Kensington Gore, London, S.W.7.

THE Journal of the Royal Microscopical Society for June (part 2, 1919) contains an important paper by Mr. J. Brontë Gatenby on the identification of intracellular structures. Considerable difficulty is often experienced in distinguishing several categories of cell elements. The Golgi apparatus, mitochondria, yolk, and fat are, or contain, substances often identical and generally chemically allied. For this reason care must be exercised in any attempt to identify a given cell body, and it is clearly recognised that the mixture of two or more of the above-mentioned elements may lead to confusion. The characteristics of the various elements of the cell which the zoologist may meet with, and the manner in which they may be distinguished by staining methods and microchemical tests, is indicated in tabular form.

THE Review of Work in 1918 of the Rockefeller Foundation has recently been issued. The activities of the foundation include a campaign against tuberculosis in France, which is mainly engaged in co-ordinating the various agencies already in existence for combating this disease. Demonstrations to test the possibility of ridding a community of malaria by anti-mosquito measures have been carried out in Arkansas with considerable success, and an epidemic of yellow fever in Guatemala has been stamped out. Measures for the control and prevention of hookworm disease have been undertaken in many tropical countries. Medical education is also encouraged by the foundation; the Pekin Union Medical College is being built under its auspices, and grants are made to many missionary hospitals. The total disbursements of the foundation for 1918 amounted to more than 15,000,000 dollars, and war-work expenditure during the war totals nearly 22,500,000 dollars.

IN an article published in a recent issue of the *North China Daily News* Mr. Austin J. Clements estimates that to maintain the trade in musk which passes across the Szechuan-Tibetan border, about 100,000 musk-deer must be captured and killed each year. The quantity of musk brought into Tachienlu, the chief centre of the trade, shows no sign of diminution, so that apparently the annual drain, large as it is, has so far had no noticeable effect on the musk-deer population of Eastern Tibet. Mr. Clements thinks it may be feasible to rear musk-deer in semi-captivity, and to collect musk from the animals without killing them. The wholesale slaughter which now goes on is largely unnecessary, since the snaring methods employed lead to the destruction of large numbers of females and immature males, whereas only male deer more than three years of age secrete musk. The article contains a good deal of information regarding the trade in musk, not the least interesting item being the statement that one firm in Tachienlu devotes itself solely to the manufacture of an adulterant, which resembles true musk in all respects save smell, the latter being provided by the addition of a small quantity of genuine musk. In coping with this and other less ingenious forms of sophistication the Chinese merchant is accustomed to rely on his personal judgment of the appearance, taste and smell, etc., of the article offered to him, so that it is not surprising that some authorities believe that all the musk exported from Tachienlu is more or less adulterated.

IN connection with the Rat Exhibition held a few months ago in the gardens of the Zoological Society of London, special investigations were made into the various methods of rat destruction. Mr. E. G. Boulenger was placed in charge of this research, and on September 26, in a lecture presided over by Prof. E. W. MacBride, and attended by a large gathering of medical officers of health, sanitary officers, and rat officers, he gave an account of the results obtained. He stated that in the course of his investigations it was ascertained that, not only had the common brown rat very greatly increased in numbers in recent years, but also that the old English black rat, or ship's rat, which was supposed to have been practically exterminated in this country by the commoner species, and to be restricted to ports and ships, had become much more abundant, and the two species of rats were now found in various parts of London living together in harmony. Where rats were present in large numbers, and where it was not practicable to use gas, poisoning was found to be the best and cheapest method to adopt for their destruction. Of all the poisons experimented with, squill, the extract of the bulb of the Mediterranean plant *Scilla maritima,* gave the greatest satisfaction. Good results were also obtained with barium carbonate. Both these poisons, Mr. Boulenger said, were, in the small quantities required to kill rats and mice, more or less harmless to domestic animals. The destructive power of virus was found to be more untrustworthy than that of some poisons. The most successful form of trap consists of a tunnel-shaped cage with open doors at each end, which shut when the rat treads on a platform in the centre of the passage. The common steel gin-trap was specially successful when covered with wire tunnels. A large number of experiments were conducted in order to ascertain whether there was any truth in the statement that rats are influenced by human odour. As a result of these experiments it was found that it was superfluous to avoid handling traps on the assumption that rats are detracted by the odour of man. Sulphur dioxide was found to be the most effective gas, and was recommended for killing rats on ships and in confined spaces. When driven off under pressure, the gas could be used with success in fumigating rat-holes in the open. Details of the research will be found in a "Report on Methods of Rat Destruction," by Mr. E. G. Boulenger, shortly to be published by the Zoological Society, price *6d.*

THE Proceedings of the United States National Museum (vol. lvi., No. 2288) contains an interesting paper entitled "Descriptions of New Species of Molluscs of the Family Turritidæ from the West Coast of America and Adjacent Regions" by Dr. W. H. Dall. In all, somewhat more than 200 species are considered, of which 181 are new. Of this large number 93 belong to the fauna of the western coast of the United States from the Arctic Ocean to San Diego, California, including one species from Hawaii. Eleven species appertain to the west coast of South America, including the Galapagos Islands; 89 belong to the Panamic fauna and its extension into the Gulf of California. The new species are well figured on twenty-four plates reproduced from excellent micro-photographs.

DURING the early days of rubber-planting, seed was put in regardless of its origin, whether from trees yielding large or from trees yielding small quantities of latex. Now, however, so much rubber is planted that there is danger of over-production, and for further plantations (now that capital costs have increased) to have much chance of success they should be planted with seed from the best bearers. Selection of seed is already in progress in Ceylon and elsewhere, and a paper by Whitby ("Variation in *Hevea brasiliensis*," *Ann. of Bot.*, vol. xxxiii., 1919, p. 313) provides useful data which give an idea of the possibilities of improvement in average yield. A large number of trees were tapped on a uniform system (in Malaya), and it was found that nearly 10 per cent. yielded twice the mean or more. If, then, the method of selection indicated in Lock's "Rubber and Rubber-Planting" (p. 101) were adopted, there seems good reason to hope that new plantations might be made yielding much more rubber per acre than the old.

THE possibilities of camphor cultivation in the West Indies has recently been discussed in the *Agricultural News* for May 31 last. The decreasing amount of camphor available for export from Japan, which has hitherto been the main source of supply, has led to experimental growth of the camphor-tree in various West Indian Islands. It has been found that some varieties of the tree yield oil only, while others yield camphor and oil, and this important botanical aspect of the question is being investigated at Kew. With the right variety, the leaves and twigs, as well as the wood and roots, are found to yield camphor on distillation, and the trees will bear severe pruning with little apparent injury. Camphor production appears to be an industry which might profitably be developed in several West Indian islands, where climatic and soil conditions are suitable; for instance, Jamaica, Trinidad, Dominica, and others. Camphor hedges as wind-breaks to lime or cacao plantations might be experimented with, even if extensive areas were not devoted entirely to camphor plantations.

AMONG recent publications of the Board of Agriculture is the first annual report of the Flax Production Branch—a branch formed in 1917 to arrange for the growth of at least 10,000 acres of flax in Great Britain. It is estimated that the 1918 crop will yield about 26,500 tons of straw and seed. The cost of production has been enormous, chiefly owing to the great difficulty in obtaining the large amount of labour necessary for harvesting the crop. Pre-war experiment stations proved the possibility of flax production on a small scale in Great Britain, but it would be obviously unfair to take last year's experience as a guide to the possibility of a large-scale flax industry. The latter will depend on foreign imports and prices, on the development of flax-growing in other countries, and also on the hitherto unattacked problem of the reduction of costs in all the stages of production. Improvements already in sight are the increased straw yield from selected strains, and the progress made with the threshing attachment which makes de-seeding on the farm possible. Also, it must be remembered that, failing the large-scale establishment of the flax industry, considerable loss will be sustained in the disposal of the machinery which has been put up during the past year.

THE recently issued volume of the Journal of the Royal Agricultural Society (vol. lxxix., 1918) contains several papers of great interest in connection with the food production campaign carried on during the war. Prof. Bryner Jones describes the results of breaking up grass-land in 1918. This will always rank as one of the most remarkable achievements of British agriculture, contributing as it did so largely to the food-supply of the country in times of great need. It was fitting, therefore, that the technical problems should be recorded and discussed. Teachers and experts will hope that an even fuller account may be published eventually, giving details of soil formations and conditions that will add to its usefulness. Mr. Garrad describes the work of the tractor on the farm. This implement is rapidly revolutionising farm conditions, and is greatly increasing the efficiency of the farm-worker. The defects of present types are set out and suggestions made for the consideration of engineers. Unfortunately, the great enemy of the tractor is the weather; in Mr. Garrad's opinion, it is essentially a fine-weather machine, and has to be laid up in winter. But it works so quickly that it enables a farmer to do much of his work during the fine periods. Mr. J. R. Bond gives an account of modern haymaking machinery, and Mr. Arthur Amos discusses the difficulties of growing red clover.

THE REV. M. SADERRA MASÒ, who has studied the seismic and volcanic phenomena of the Philippine Islands for many years, has recently published the catalogue of earthquakes for the year 1918 (U.S. Weather Bulletin for December, 1918). Excluding after-shocks, the total number of earthquakes is 167, three of which were recorded all over the world. The most important earthquake was that which occurred in Southern Mindanao on August 15 at 12.20 p.m., G.M.T., its epicentre being in 5·5° N. lat. and 124·5° E. long. This shock, the intensity of which reached the highest degree (10) of the Rossi-Forel scale, was followed by thousands of after-shocks (some of them of degrees 7 and 8) during the months of August, September, and October. It was followed by a sea-wave, which swept over the southern coast of Catabato, causing great damage and loss of life. About a month later, on September 13, there were two violent shocks in the Batanes Islands, the first of intensity 8 at 6.56 a.m., the second of intensity 9 at 11.5 a.m., by which the towns of Sabtan and Ivana were destroyed.

THE Bulusan volcano rises on the south-east end of the island of Luzon to a height of about 5000 ft. For centuries—indeed, so far back as the historic record extends—it has been dormant, only occasionally ejecting small jets of steam from numerous vents around its breached and nearly filled-up crater. A few light outbursts with ejection of ashes are reported as having occurred in 1852, 1889, and 1894. Far more important were the eruptions which took place in January, 1916, and October, 1918, and are briefly described by the Rev. M. Saderra Masò in the U.S. Weather Bulletin for January last. The first began on January 16, 1916, and lasted five days, with numerous earth-tremors and rumbling noises and small explosions. The eruption of October, 1918, was more violent, and at the end of December incandescent lava began to pour down a deep ravine on the south-south-west side of the mountain, continuing until the end of March, 1919. The damage caused by the eruptions is of little account; indeed, the plantations on the lower flanks of the volcano have been benefited by the small falls of ashes.

Symons's Meteorological Magazine for September inaugurates the passing of the magazine from the British Rainfall Organisation to the Meteorological Office as a part of the unification of the British Meteorological Services. The Thames Valley rainfall map for August shows the general rains to have ranged during the month from 2 in. to 4 in., the rains being heaviest in the southern districts of Hampshire and Sussex. In London and over a large part of Middlesex the rains measured about 2·5 in., the least rains amounting to 2 in. and less over the estuary of the Thames.

THE Monthly Meteorological Chart of the North Atlantic Ocean published by the Meteorological Office, in addition to the usual information dealing with matters of especial interest to the seaman, has on the face of the chart a note on the increasing storm tendency during the autumn. Attention is directed to the fact that during the winter half of the year both anticyclones and cyclones are of greater intensity than those of the quieter months of summer, the barometer during the winter season both rising higher and falling lower, which accounts for the greater severity of the wind. As an illustration of the irregular track of storms at times, attention is directed to a storm experienced by H.M.S. *Caesar* in the neighbourhood of Bermuda during the early days of September, 1915, when the storm's path seems to have nearly completed a circle and then to have doubled back over a considerable area. To confirm so erratic a path, a minute discussion of neighbouring and surrounding observations seems desirable. Autumn is referred to as the most stormy period for hurricanes in the tropical belt, but the accumulated data for many years show August as the most stormy month for West Indian hurricanes. Charts are given of the North Polar seas for the months from April to August inclusive, taken from the "State of the Ice in the Arctic Seas, 1918," published by the Danish Meteorological Institute.

THE developments of aerial photography during the war seem likely to be put into practical use in peace-time in connection with surveying and cartographic work. In *La Nature* for September 6, P. Dautriche expresses the opinion that the field of application for aero-photography seems to comprise (1) land cartography (revision and explorations); (2) marine cartography or charting; (3) the preparation of large-scale maps and plans for various public works enterprises; and (4) control work (forest sections, the traffic of ports, stations, etc.). His article develops the subject in an elementary way by simple examples of the method of procedure.

A WRITER in *La Nature* (September 6) sketches the development of the French Ministry of Inventions from its inception in 1915. The Department has been responsible, like the British War Inventions Department, for carrying out numerous investigations related to matters of artillery, small arms, lorries, tanks, aircraft, and shipping. One of the most useful inventions which was the outcome of much experiment by Prof. Perrin and his collaborators is a method of acoustic signalling by means of a compressed-air trumpet. The apparatus, which is quite portable, comprises two clarions or bugles having different notes and a compressed-air cylinder. It has a range of several kilometres. Much valuable work was done, too, on the photography of projectiles at extra high speeds. Mention is also made of Prof. Rothé's method of recording wind velocity by means of small anemometers and mills attached to captive balloons, the anemometers closing an electric circuit at intervals of 10 m. of change in wind force.

AN interesting pamphlet has been issued by the Niagara Falls Chamber of Commerce relating to the electro-chemical industries established at the Falls. The power at present utilised amounts to 605,000 h.p., whilst schemes in process of development will absorb a further 420,000 h.p. It is estimated that a total of 2,500,000 h.p., equivalent to more than 16,000,000 tons of coal per annum, may be obtained without impairing the natural beauty of the Falls. The substances produced by the various companies cover a wide range, and include abrasives, refractories, fertilisers, metals and alloys, inorganic compounds, and a variety of organic substances such as chloroform, methyl alcohol, and formaldehyde. When cheap power is available, electro-chemical methods of production often prove cheaper than alternative processes, and to this fact may be attributed the rapid development of hydro-electric schemes in all countries where water-power is available on a sufficiently large scale. The policy of the United States is to utilise water-power to the fullest extent, thereby conserving fuel; and it is worth while considering whether the British Empire could not act as a whole in this connection, particularly in view of the present situation in relation to coal supplies. Judging from the success already achieved at Niagara, it appears probable that a continuously increasing proportion of chemical and metallurgical products will emanate from water-power centres in the future.

WE have received a copy of an interesting pamphlet (obtainable from the editor of the *British Baker*, Messrs. MacLaren and Sons, Ltd., 38 Shoe Lane, E.C., price 1s.) by Capt. Robert Whymper on "The Conditions that Govern Staleness in Bread." For the greater part the report deals with work carried out by Capt. Whymper himself as Assistant Inspector of Bakeries with the Army in France, and it extends over far too large a field for complete abstraction here. The questions studied include the estimation and location of losses occurring in the manufacture of bread, the conditions that govern staleness in bread, changes occurring in bread with age, and the colloid nature of bread-crumb. The conclusions arrived at are as follows:—(1) The cooling of bread takes place in three stages: a steam period, a condensation period, and a drying period, the rate of loss of moisture of the first being four times as great as that of the drying period and five times that of the condensation period. (2) No marked loss of moisture from the centre of the loaf occurs until after 100 hours, and within the latter period the zone of drying is a layer only 1 in. thick adjacent to the outer crust. (3) The loss of water from a loaf on keeping is not responsible for staleness. (4) As the loaf becomes stale there is a fall in the amount of soluble extract of the bread-crumb, followed by a rise, the soluble starch falling rapidly between six and twenty-four hours' cooling. This supports Lindet's view that staleness is due to the retrogression of soluble starch. A similar fall and rise of soluble extract has been observed with starch pastes. Capt. Whymper considers that staleness may be attributed to (i) deposition of solid starch in the bread-crumb by change of temperature and accelerated by the pre-existence of solid starch particles; and (ii) partial polymerisation of starch independent of the deposition mentioned, which tends to crumble the gelatinous nature of the bread-crumb. Changes occurring in the proteins of the bread may also be a cause of staleness.

Messrs. Baillière, Tindall, and Cox have in the press for appearance in their Industrial Chemistry Series:—"Explosives," E. de Barry Barnett; "The Industrial Gases," Dr. H. C. Greenwood; "Animal Proteids," H. G. Bennett; and "The Carbohydrates," Dr. S. Rideal. The following volumes are in preparation for the same series:—"Fats, Waxes, and Essential Oils," W. H. Simmons; "Silica and the Silicates," J. A. Audley; "The Rare Earths and Metals," Dr. E. K. Rideal; "The Iron Industry," A. E. Pratt; "The Steel Industry," A. E. Pratt; "Gas-works Products," H. H. Gray; "Organic Medicinal Chemicals," M. Barrowcliff and F. H. Carr; "The Petroleum Industry," D. A. Sutherland; "Wood and Cellulose," R. W. Sindall and W. Bacon; "Rubber, Resins, Paints, and Varnishes," Dr. S. Rideal; and "Economic Fuel Production in Chemical Industry," Dr. H. S. Taylor.

ERRATUM.—On p. 84 of NATURE of September 25, in the Table in column two, 95·4 appeared under S(aturn) in some copies as 5·4, the 9 having been broken off during printing.

OUR ASTRONOMICAL COLUMN.

THE TWENTY-FOUR-HOUR DAY.—The spirit of standardisation and unification is abroad, and one of its latest manifestations is the attempt to reduce the various methods of time-reckoning to a single system. Astronomers have made an important contribution to this end in deciding to commence the astronomical day at midnight instead of noon. This reform will commence in the year 1925, an earlier date being inconvenient for the various nautical almanacs. While astronomers will gain, on the whole, by the change, yet in some respects, notably in the case of sets of observations extending on both sides of midnight, it will cause inconvenience; this gives them a certain claim to ask for some sacrifice on the part of the general public in order to achieve the further unification which is now desired; this is the substitution of 24-hour reckoning for the present system of a.m. and p.m.

Twenty-four-hour time has long been used in Italy; it was introduced into the British Army last year, and a few railway companies already use it in their time-tables, where its convenience is so manifest that it is surprising that its introduction has been so tardy.

The majority of social functions take place in the afternoon or evening, and it undoubtedly is somewhat more troublesome to say seventeen than five, or twenty-one than nine. *Punch* made some amusing play on this subject when the reform was suggested in 1885; possibly this had something to do with the failure to carry it at that date. However, the fact that astronomers could not then agree to alter the astronomical day deprived the scheme of its driving-power. The auspices are now more favourable, and the report of the Committee, consisting of seven members, just appointed by the Home Secretary will be awaited with interest.

COMETS.—Using observations made on August 21, 29, and September 7, Messrs. Braae and Fischer-Petersen have deduced the following elliptical orbit of the comet 1919*b*:—

$$T = 1919 \text{ Oct. } 16{\cdot}861 \text{ G.M.T.} \qquad \log a = 1{\cdot}23860$$
$$\left.\begin{array}{l}\omega = 129^\circ\ 32{\cdot}11' \\ \Omega = 310^\circ\ 43{\cdot}41' \\ i = 19^\circ\ 11{\cdot}45'\end{array}\right\}1919{\cdot}0 \qquad \begin{array}{l}\log e = 9{\cdot}98767 \\ \log q = 9{\cdot}68544 \\ \text{Period } 72{\cdot}095 \text{ years}\end{array}$$

The elements are extremely close (within about 5′ in each case) to Gould's elements for 1847 when corrected for precession. The error of the middle place in longitude (great circle) is −0·50′, in latitude +0·51′. The period adopted is simply the observed interval between the two perihelia, uncorrected for perturbations.

Ephemeris for Greenwich Midnight.

	R.A. h. m. s.	N. Decl. ° ′	Log *r*	Log Δ	Mag.
Oct. 1 ...	11 46 46	25 14	9·7836	9·7184	6·8
5 ...	11 45 19	20 52			
9 ...	11 46 13	16 46	9·7130	9·8392	7·3
13 ...	11 49 41	12 49			
17 ...	11 55 30	8 55	9·6856	9·9440	7·9

The comet will be observable as a morning object in Europe until early in December; after that it will pass to the south of the sun, and will be better placed for southern observers. It is very desirable to observe it as long as possible, in order to place the elliptical character of its orbit beyond a doubt.

The physical appearances of the three visible comets are discussed in *L'Astronomie* for September. 1919*a* (Kopff) appeared as a circular nebulosity some 3′ in diameter, gradually increasing in brightness towards the centre, where there was a nucleus of the 12th mag.; no trace of a tail. 1919*b* (Metcalf-Brorsen) was visible to the naked eye on September 5, in spite of strong moonlight. In the telescope it appeared as a large nebulosity, with eccentric condensation, and a short but broad tail pointing S.W. 1919*c* (Metcalf-Borrelly) appeared early in September as a pale nebulosity, 2′ in diameter, with slight central condensation; observation difficult owing to moonlight.

MINOR PLANETS.—A sixth member of the interesting Trojan group of planets (the mean motion of which is the same as that of Jupiter) was found in March last, and provisionally designated 1919 FD. Its mean longitude is 60° greater than that of Jupiter. Prof. Cohn gives the following elements:—

Epoch 1919 March 19·5 G.M.T.

$$M_0 = 88^\circ\ 48'\ 18{\cdot}9''$$
$$\left.\begin{array}{l}\omega = 78^\circ\ 46'\ 7{\cdot}8'' \\ \Omega = 336^\circ\ 55'\ 10{\cdot}5'' \\ i = 21^\circ\ 56'\ 49{\cdot}8''\end{array}\right\}1919{\cdot}0$$
$$\phi = 4^\circ\ 55'\ 43{\cdot}4''$$
$$\mu = 303{\cdot}190''$$
$$\log a = 0{\cdot}712194$$

Four of the Trojans have longitude 60° greater than Jupiter, and two 60° less.

FLORA OF MACQUARIE ISLAND.

THE recently issued part of the Scientific Reports of the Australasian Antarctic Expedition, 1911–14 (series iii., vol. vii., part 3), entitled "The Vascular Flora of Macquarie Island," by T. F. Cheeseman, contains some important conclusions on the origin and distribution of the southern floras. Macquarie Island is situated on a narrow submarine ridge, surrounded by water more than 2000 fathoms deep, about 600 miles to the south-west of New Zealand. Its greatest length is barely twenty-one miles, and its greatest breadth under four miles. The island is little more than a range of mountains, the exposed ridges bare and wind-swept, while in the hollows are numerous shallow lakes, and the coastal hills are deeply scored by ravines. The climate is marked by a low summer temperature, much cloud and fog, and constant high winds. Dr. J. H. Scott, who visited the island in 1880, describes the landscape as barren in the extreme. There is not a tree or shrub, but long stretches of yellow tussock are varied with patches of the bright green *Stilbocarpa polaris,* the Macquarie Island cabbage, a plant resembling very fine rhubarb in growth, and of Pleurophyllum, a handsome Composite, with long, sage-green leaves and purple flowers. On the hillsides are globular masses of Azorella, forming dense, solid cushions often 4 ft. across. Near the hilltops is an abundant growth of rich brown mosses. Hooker ("Flora Antarctica") mentions seven species of flowering plants and one fern as known from the island. Mr. A. Hamilton, on whose collections the present account is based, spent nearly two years in the island, and Mr. Cheeseman now enumerates thirty flowering plants and four ferns. Of these, three grasses are endemic, while of the remaining thirty-one species eighteen extend to New Zealand, and eleven of these are found in no other country. A remarkable fact is that fifteen, or practically one-half of the non-endemic plants, are also found in Fuegia or the South Georgia to Kerguelen groups of islands. Fuegia lies 4600 miles east of Macquarie Island, with no trace of land between, and South Georgia, further east, at about 5800 miles. Westward there is open sea until Kerguelen Island is reached, about 3250 miles distant. The extraordinarily scanty flora of the South Georgia-Kerguelen-Macquarie areas, which lie between parallels roughly corresponding with the north of England and the centre of France, is probably due mainly, as Prof. Rudmose Brown has suggested, to the short summer with its comparatively low temperature; but the almost continuous westerly gales must also act adversely on plant growth.

After a brief comparative review of the vegetation of the various land areas of the sub-Antarctic zone, Mr. Cheeseman concludes that during Tertiary times there have been only two directions in which the vegetation of the rest of the world can have approached the sub-Antarctic zone and Antarctica itself, or along which an interchange of species could take place, namely, the direction of New Zealand and that of South America. The rich and varied flora of New Zealand, in addition to its obvious Australian, Pacific, and Malayan alliances, has also an evident Andine and Fuegian affinity, which is still greater in the New Zealand sub-Antarctic islands. These islands in early Tertiary times were part of a greater New Zealand, and a northward extension of Antarctica might have reduced the distance between it and the New Zealand area to one capable of being passed by plants and animals. An indication of a former continuous or broken land connection between Antarctica and South America, presumably in Oligocene times, is found in the comparatively shallow bank which curves round by way of the Falkland Islands and South Georgia. The fossil Tertiary flora discovered by Dr. Andersson in Graham Land, comprising species of well-known recent South American and New Zealand genera, is of interest from this point of view. It suggests an Antarctica largely free from ice and snow, and supporting a numerous flora along the shores of the continent. We may imagine a regular exchange of species between Antarctica and Fuegia, and also a passage of species between New Zealand and Antarctica. In this way we may account for the presence of a New Zealand element in the South American flora and a South American element in New Zealand.

The subsequent Glacial epoch caused much extinction of species in the southern flora. At its close Macquarie Island had lost its higher plants except the few grasses which now constitute its endemic flora, Kerguelen had suffered almost as badly, and in South Georgia the whole of the vascular flora had perished. With the advent of a milder climate only two sources of supply remained, Fuegia and the New Zealand area. South Georgia and the Kerguelen group, both favourably placed in the line of the constant westerly winds, received almost the whole of their new flora from Fuegia, while Macquarie Island obtained a large proportion from the comparatively close New Zealand sub-Antarctic islands.

EDUCATION IN BRITISH INDIA.

THE Bureau of Education, India, has issued an interesting quinquennial review of the progress of education in British India for the period 1912–17. The facts are set forth in a statistical abstract covering 100 folio pages. They deal with all forms of education, primary, secondary, professional, and university, under various heads, such as the number of institutions public and private, the scholars in attendance, local and State expenditure, number and qualifications of the teachers, and cost of education in elementary and secondary schools and in professional and university colleges. The statistics differentiate between the various races, together with Europeans and Anglo-Indians, and between the different creeds, including Hinduism, Mohammedanism, and Buddhism. The returns refer only to British India, with an area of 1,034,716 square miles and a population of about 244,000,000, of which number 124,747,805 are males and 119,273,295 females. The Hindus number 163,611,094, Mohammedans 57,419,309, Buddhists 10,642,812, Parsis 86,155, Europeans and Anglo-Indians 265,254, Indian Christians 2,226,464, others 9,989,185—figures of much interest in view of the present Indian unrest. Of this vast number only 7,851,946, in which is included 1,230,419 females, are under instruction in all types of educational institutions, or about 3 per cent. of the population. In 1906–7 only 5,388,632 were under instruction, and in 1911–12 6,780,721.

The number of arts colleges in 1916–17 was 134 with 47,135 students; of professional colleges, 61 with 11,504 students; of special schools, inclusive of training, medical, agricultural, and other technical schools, 4861 with 143,604 students; of secondary schools, 7693 with 1,186,335 pupils; of primary schools, 142,203 with 5,818,730 pupils. In addition to these there were 37,803 private institutions, 3009 of which were advanced with 60,618 pupils, and 34,794 were elementary with 584,020 pupils. The total expenditure on public instruction in 1916–17 was 7,525,537*l*., of which sum there was spent on administration, inspection, scholarships, buildings, furniture, apparatus, etc., 2,239,749*l*. On the arts colleges there was spent 473,583*l.*, on the professional colleges 239,961*l.*, on the training schools 190,920*l.*, on all other special schools 298,474*l.*, on the secondary schools 2,128,612*l.*, and on the primary schools 1,954,236*l.* There was a total income from fees in 1916–17 of universities, professional colleges, and special technical schools of 107,453*l.*, and of secondary schools of 242,620*l.* In 1917 14,799 students matriculated, 4209 qualified for the B.A. examination, 440 for B.Sc., 555 for M.A., and 152 for M.Sc. An elaborate census of education such as this for the United Kingdom would be a welcome contribution to our knowledge of educational affairs.

THE BRITISH ASSOCIATION AT BOURNEMOUTH.

SECTION C.

GEOLOGY.

OPENING ADDRESS (ABRIDGED) BY J. W. EVANS, D.SC., LL.B., F.R.S., PRESIDENT OF THE SECTION.

ONE of the most striking features of our science is the need in which it stands of a large and widely distributed body of workers, and the opportunities it affords to every one of them of making important contributions to scientific knowledge.

Everywhere someone is needed who will devote his spare time to the examination of the quarries and cliffs, where the materials that build up the solid earth are exposed to view, and who will record the changes that occur in them from time to time; for a quarry that is in work, or a cliff that is being undermined by the sea, constantly presents new faces, affording new information, which must be recorded if important links in the chain of evidence are not to be lost. It is equally important that someone should always be on the look-out for new exposures, road or railway cuttings, for instance, or excavations for culverts or foundations, which in too many instances are overgrown or covered up without receiving adequate attention. It is, again, only the man on the spot who can obtain even an approximately complete collection of the fossils of each stratum, and thus enable us to obtain as full a knowledge as is possible of the life that existed in the far-off days in which it was laid down. In his absence, many of the rarer forms which are of unique importance in tracing out the long story of the development of plants and animals, and even of man himself, never reach the hands of the specialist who is capable of interpreting them. It was an amateur geologist, a country solicitor, who saved from the road-mender's hammer the Piltdown skull, that in its main features appears to represent an early human type, from which the present races of man are in all probability descended. Another amateur, who was engaged in the brick-making industry near Peterborough, has provided our museums with their finest collections of Jurassic reptiles. A third, a hard-worked medical man, was the first to reveal the oldest relics of life that had at that time been recognised in the British Isles; and many more examples could be instanced of the services to geological science by those whose principal life-task lay in other directions.

Such workers are, unfortunately, all too few—fewer, I fancy, now than they were before the pursuit of sport, and especially of golf, had taken such a hold upon the middle classes and occupied so considerable a portion of their leisure hours and thoughts. One might hope that the extended hours now assured to the working classes for recreation would lead to a general increase of interest in science among them, if it were not that the students of that admirable organisation, the Workers' Educational Association, seem almost invariably to prefer economic or political subjects to the study of Nature. In a large county in which I am interested the number of those in every condition of life who are able and willing to take part in geological research might be told almost on the fingers of one hand, and, so far as I am aware, there has not been a single recruit in recent years from the ranks of the younger men or women.

It might be suggested that the prevailing indifference to the attraction of geological research was due to a conviction that after eighty years of work by the Geological Survey, as well as by university teachers and amateurs, there was little left to be done, and that all the information that could be desired was to be found in the Survey publications. Such a belief can scarcely be very widespread, for, as a matter of fact, comparatively few of the general public realise the value of the work of the Geological Survey, and still fewer make use of its publications. Municipal libraries, other than those of our largest provincial centres, are rarely provided with the official maps and memoirs relating to the surrounding areas, and in the absence of any demand the local booksellers do not stock them. This cannot be attributed to the cost, for, though most of the older maps are hand-coloured and therefore expensive, the later maps—at least, those on the smaller scales[1]—are remarkably cheap, and the memoirs are also issued at low prices. The true explanation appears to be that a geological map conveys very little information to the average man of fair education who has received no geological instruction. This is certainly not the fault of the Survey maps, which compare very favourably with those of other countries, and have been greatly improved in recent years. In particular, the introduction of a longitudinal section on each map and the substitution of the vertical section drawn to scale for the old colour index must greatly assist those into whose hands it comes in obtaining a correct view of the succession of the strata and the structure of the country. Some of the maps are, it is true, so crowded with information—topographical and geological—that it is frequently difficult, even for the trained geologist, to read them without a lens. This is largely due to the fact that they are printed over the ordinary topographical maps in which there is a great amount of detail that is not required in geological maps. In India the Trigonometrical Survey are always ready to supply, as a basis for special maps, copies of their own maps printed off plates from which a portion of the topographical features have been erased.

The best remedy, however, would be to extend the publication of the maps on a scale of 6 in. to a mile (1 : 10,560). For many years all geological survey work has been, in the first place, carried out on maps of this scale, but they have not been published except in coal-mining areas. There the geological boundaries are printed, but the colouring is added by hand, which makes the maps comparatively expensive. In other localities manuscript copies of the geological lines and colouring on the Ordnance Survey maps can be obtained at the cost of production, which is necessarily considerable. There is, I believe, a wide sphere of usefulness for cheap colour-printed 6-in. geological maps, especially in the case of agricultural and building land, for which the 6-in. Ordnance maps are already in demand. They afford ample room for geological information, and, accompanied by longitudinal sections on the same scale without vertical exaggeration, their significance would

[1] 1 in. to the mile, 1 : 63,360; ¼ in. to the mile, 1 : 253,440, and 1 in. to 25 miles, 1 : 1,584,000.

be more readily apprehended than that of maps on a smaller scale.

It would be of great advantage if there were a uniform usage by which the position in the stratigraphical series of rock outcrops were indicated by colour and their lithological character by stippling (in black or white or colour), following the ordinarily accepted conventions. This course has been pursued by Prof. Watts in the geological map prepared by him to illustrate his "Geography of Shropshire."

Some explanation, apart from the maps themselves, is, however, needed if they are to be rendered, as they should be, intelligible to the general public. The official memoirs which deal with the same areas as the maps do not afford a solution of the difficulty. Excellent as they are from the technical point of view and full of valuable information, they convey little to the man who has not already a considerable acquaintance with the subject. What is needed is a short explanatory pamphlet for each map, presuming no previous geological knowledge, describing briefly and in simple popular language the meaning of the boundary lines and symbols employed, and the nature and composition of the different sedimentary or igneous rocks disclosed at the surface or known to exist below it in the area comprised in the map. A brief account of the fossils and minerals visible without the aid of a microscope should also be included. The probable mode of formation of the rocks and their relation to one another and the subsequent changes they have undergone should be discussed, and at the same time their influence on the agriculture value of the land and its suitability for building sites, as well as on the distribution and level of underground water, pointed out. Some account, too, should be given of the economic mineral products and their applications. These pamphlets should be illustrated by simple geological sections, views of local quarries and cliffs showing the relative positions of the different rocks, figures of the commoner fossils at each horizon, and, where they would be useful, drawings of the forms assumed by the minerals. Each pamphlet would be complete in itself. This would involve a considerable amount of repetition, but it must be remembered that different pamphlets would have, as a rule, different readers.

During the war publications containing desirable information were circulated widely and gratuitously by the authorities to all public bodies concerned, and there seems no reason why the information laboriously gathered by the Geological Survey in the national interests and paid for out of the public funds should not now receive the same treatment. All municipalities, district councils, public libraries, colleges and schools, both secondary and elementary, should receive free copies of the Geological Survey publications dealing with the area where they are situated or with those immediately adjoining it.

Every facility should, of course, be afforded to the public to make use of the Survey publications. They should not only be on sale at the post offices in the areas to which they relate, but it should also be possible to borrow folding mounted copies of the maps as well as bound copies of the explanations and memoirs, on making a deposit equal to their value. When they were no longer required, the amount of the deposit, less a small charge for use, would be repaid on their return to the same or any other post office and the production of the receipt for cancellation. It would thus be possible, when traversing any part of the country, to consult in succession all the Geological Survey publications of the districts passed through. This system would also enable the permanent residents to refer to the more expensive hand-coloured maps, including the 6-in. manuscript maps, at a comparatively small cost.

The Survey publications should be illustrated in every museum and school in the districts with which they deal by small collections showing the characters of the local rocks, and of the minerals and fossils that occur in them, and care should be taken to see that these collections are maintained in good order and properly labelled.

It would be a good plan for the Survey to appoint a local geologist, an amateur or member of the staff of a university or college, in every area of twenty or thirty square miles to act as their representative and as a centre of local geological interest. He would be expected to given his assistance to other local workers who stood in need of it. He would receive little official remuneration, but inquirers in the neighhood would be referred to him, and where commercial interests were involved he would, subject to the sanction of the central office, be entitled to charge substantial fees for his advice. He would report to the Survey any event of geological importance in the area of which he was in charge—whether it was the discovery of a new fossiliferous locality, the opening of a new quarry,[2] the sinking of a well, or the commencement of boring operations. Many of these matters would be adequately dealt with by local workers, but in other cases it might be desirable for the Survey to send down one of their officers to make a detailed investigation.

One of the most important duties of the Survey, or of its local representative, would be to see that the records of well-sinkings and borings are properly kept, and that where cores are obtained the depth from which each was raised is accurately recorded. At the present time the officers of the Survey make every effort to see that this is done, but they have no legal power to compel those engaged in such operations to give the particulars required. Equally important is a faithful record of the geological information obtained in prospecting or mining operations. This is especially necessary where a mine is abandoned. If care is not then taken to see that all the information available is accurately recorded, it may never be possible later to remedy the failure to do so.

Probably these objects would be much facilitated if engineers in charge of boring or mining operations had sufficient knowledge of geology and interest in its advancement to make them anxious to see that no opportunity was lost of observing and recording geological data. This would be in most cases ensured if every mining student were required to carry out geological research as part of his professional training. It is now recognised that no education in science can be considered to be up to university standard if it is limited to a passive reception of facts and theories without any attempt to extend, in however humble a way, the boundaries of knowledge. In the case of geology such research will naturally in most cases take the form of observations in the field. The important point is that the work must be original, on new lines, or in greater detail than before, and not a mere confirmation of published results. It is only by the consciousness that he is accomplishing something which has not been done before that the student can experience the keen pleasure of the conquest of the unknown and acquire the love of research for its own sake.

There is one respect in which geological workers

[2] It is very desirable that arrangements should be made for the co-operation of the Geological Survey or their local representatives with the Inspectors of Quarries appointed by the Home Office, and that the annual official list of quarries should describe the rocks which are worked, not only by their ordinary economic designations, but also by their recognised geological descriptions.

suffer a heavy pecuniary handicap—the cost of railway fares. This affects both the staff and students of colleges, as well as local workers who are extending their radius of work—an inevitable necessity in the investigation of many problems. It also seriously interferes with the activity of local natural history societies and field clubs, the geological societies and associations of the great provincial towns, and, above all, that focus of amateur geological activity—the Geologists' Association of London. It is difficult to exaggerate the importance of these agencies in the promotion of geological education. Both professional and amateur geologists are deeply indebted to the excursions which are in most cases directed by specially qualified workers, with whom it is a labour of love. At the same time one of their most valuable results is the creation of interest in scientific work in the localities that are visited. Now that the railways are, if report speaks truly, to be nationalised, or at any rate controlled by the State, the claims of scientific work, carried out without reward in the national interest, to special consideration will surely not be ignored. All questions as to the persons to whom such travelling facilities should be extended and the conditions that should be imposed may safely be left to the decision of the Geological Survey, which has always had the most friendly and sympathetic relations with private workers and afforded them every facility and assistance which their comparatively limited staff and heavy duties permitted.

There is at the present time a very urgent need for the provision of further facilities for the analysis of rocks and minerals to assist and complete the researches both of the official surveyors and of private persons engaged in research. The work is of a very special character, and the number of those who have given sufficient attention to it and understand its difficulties and pitfalls is very limited.

The analytical work of the Survey is organised on a very modest scale in comparison with the *personnel* and equipment of the laboratory of the United States Geological Survey, though the quality of the work has been, as a rule, in recent years quite as high. There are two analytical chemists attached to the Geological Survey, and some of the other members of the staff are capable of doing good analytical work. The demand, however, for analyses for economic purposes is so great that it is impossible to carry out all the analyses that would be desirable in connection with the purely scientific work of the Survey itself. There is, consequently, no possibility of their being able to assist private investigators.

In the absence of facilities for obtaining rock analyses, petrological work in this country is at present seriously handicapped. A striking illustration of the inadequate provision for analyses is revealed in the fact that for the whole of the early Permian granitic intrusions in the south-west of England, covering nearly two thousand square miles, and including numerous different types and varieties, there are only four analyses in existence, and of these two are out of date and imperfect. This is all the more remarkable in view of the fact that these rocks are closely connected with the pneumatolytic action that has given us almost all the economic minerals of the south-west of England.

Another direction in which the work of the Survey could with advantage be extended is in the execution of deep borings[3] on carefully thought out schemes by which a maximum of information could be obtained. Both in Holland and Germany borings have been carried out to discover the nature of the older rocks beneath the Secondary and Tertiary strata, and Prof. Watts in his presidential address to the Geological Society in 1912, dwelt on the importance of exploring systematically the region beneath the wide spread of the younger rocks that covers such a great extent of the east and south of England. Prof. Boulton, my predecessor in this chair, has endorsed this appeal, but nothing has been done or is apparently likely to be done in this direction. It seems extraordinary that no co-ordinated effort should have been made to ascertain the character and potentiality of this almost unknown land that lies close beneath our feet and is the continuation of the older rocks of the west and north to which we owe so much of our mineral wealth. It is true that borings have been put down by private enterprise, but, being directed only by the hope of private gain and by rival interests, they have been carried out on no settled plan, and the results, and sometimes the very existence, of the borings have been kept secret. The natural consequences of this procedure have been the maximum of expense and the minimum of useful information.

Unfortunately, in recent years percussion or rope-boring, which breaks up the rock into fine powder, has more and more, on account of its cheapness, replaced the use of a circular rotating drill, which yields a substantial cylindrical core that affords far more information as to the nature of the rocks and the geological structure of the district. If private boring is still to be carried on, the adoption of the latter procedure should be insisted on, even if the difference of cost has to be defrayed by the Government. It is quite true that a considerable amount of useful information can be collected by means of a careful microscopic examination of the minute fragments which alone are available for study, so that the nature of the rocks traversed can be recognised; but the texture of the rock is destroyed, as well as any evidence which might have been available of its larger structures and stratigraphical relations, and almost all traces of fossils. It is, too, impossible to tell with certainty the exact depth at which any particular material was originally located, for fragments broken off from the sides of the bore may easily find their way to the bottom.

A good illustration, and one of many that might be cited, of the misdirected energy that is sometimes expended in prospecting operations was afforded a few years ago by a company that put down a boring for oil through more than a thousand feet of granite without being aware of the nature of the rock that was being traversed. In this case a percussion drill was employed, but a few minutes' examination of the material should have enabled the engineer in charge, supposing he had even an elementary knowledge of geology, to save hundreds of pounds of needless expenditure. The sum total of the funds which have been uselessly expended in this country alone in hopeless explorations for minerals, in complete disregard of the most obvious geological evidence, would have been sufficient to defray many times over the cost of a complete scientific underground survey.

If research is to be carried out economically and effectively, it must be organised systematically and directed primarily with the aim of advancing knowledge. If this aim be well and faithfully kept in view, material benefits will accrue which would never have been thought to be sufficiently probable to warrant the expenditure of money on prospecting.

It is, however, not only in the areas occupied by Secondary or Tertiary rocks that systematic boring is urgently needed. There are many other localities where important information as to the structure of

[3] I have not space to deal here with the shallow borings in soft strata which have been so successfully conducted on the Flanders front during the war by Capt. W. B. R. King, of the Geological Survey.

the rocks could probably be obtained in this manner. Opinion is very much divided as to the relation of the Devonian to the older rocks in South Devon and Cornwall, but there is little doubt that a series of judiciously placed borings would solve the problem without difficulty. In North Devon and West Somerset the question as to whether the Foreland Grits are a repetition by faulting of the Hangman Grits could also be settled at once by borings in the Foreland Grits and in the Lynton beds.

It is not, however, on *terra firma* alone that such investigations may be usefully carried out. The floors of the shallow seas that separate these islands from one another and from the continent of Europe are still almost unknown from the geological point of view, although their investigation would present no serious difficulties. Joly has described an electrically driven apparatus which, when lowered so as to rest on a hard sea-floor, will cut out and detach a cylindrical core of rock, and retain it until raised to the surface. Afterwards he invented a still more ingenious device, in which the force of the sea-water entering an empty vessel is substituted for electrical power, but, unfortunately, neither the one nor the other has actually been tried or even constructed.

Meantime, however, vertical sections up to 80 cm. of the mud of the deep seas have actually been obtained in iron tubes attached to sounding apparatus employed in the course of the voyage of the *Gaussberg*. These reveal a succession of deposits of which the lower usually indicate colder water conditions than the upper.

In many places rock fragments are dredged up by fishing-boats. These should, of course, be used with caution in drawing conclusions as to the distribution of rocks *in situ* on the sea-bottom, as such fragments may have been transported when embedded in ice-sheets or in icebergs or other forms of floating ice, or entangled in the roots of floating trees; but where the rock fragments can be shown to have a definite distribution, as in those described by Grenville Cole and Thomas Crook from the Atlantic to the west of Ireland, and by R. H. Worth from the western portion of the English Channel, they may be regarded as affording trustworthy information as to the geology of the area.

There seems every reason to believe that advances in submarine geology will not be only of scientific interest, but will bring material benefits with them. It seems quite possible that off the shores of Northumberland and Durham there are, in addition to extensions of the neighbouring coalfield, Permian rocks containing deposits of common salt, sulphate of calcium (gypsum and anhydrite), and, above all, potash salts comparable to those at Stassfurt, which have proved such a source of wealth to Germany.

No less important than the work of the Geological Survey is that of our great national museums. I have already alluded to the need for local collections to illustrate the geology of the areas in which they are situated. The museums of our larger cities and our universities will naturally contain collections of a more general character, but it is to our national museums that we must chiefly look for the provision of specimens to which those engaged in research can refer for comparison, and it is imperative that they should be maintained in the highest state of efficiency if the best results are to be obtained from scientific investigations in this country. The ability and industry of the staff of the mineral and geological departments of the Natural History Museum are everywhere recognised, as well as their readiness to assist all those who go to them for information, but in point of numbers they are undeniably insufficient to perform their primary task of examining, describing, arranging, and cataloguing their ever-increasing collections so as to enable scientific workers to refer to them under the most favourable conditions.[4] Even if the staff were doubled, its time would be fully occupied in carrying out these duties, quite apart from any special researches to which its members would naturally wish to devote themselves. The additional expense incurred by the urgently needed increase of the museum establishment would be more than repaid to the country in the increased facilities afforded for research.

There is room, too, for a considerable extension in the scope of the activity and usefulness of our museums in other directions, and more especially in the provision of typical lithological collections illustrating the geology of different parts of the British Empire and of foreign countries.

So far as the United Kingdom is concerned, this requirement has been admirably fulfilled in the museums attached to the Survey headquarters in London, Edinburgh, and Dublin, and there is a smaller collection of the same nature, excellent in its way, at the Natural History Museum. But to obtain a broad outlook it is essential that the attention of geological workers should not be confined to one country, however diversified its rocks may be, and it is impossible to assimilate effectively publications dealing with the geology of other parts of the world without being able to refer to collections of the rocks, minerals, and fossils described.

Such collections should include not only rock specimens in the ordinary sense of the term, but also examples of metalliferous veins and other mineral deposits which present important distinctive features.

The lithological and palæontological collections which I am now advocating should be arranged so that each group of specimens illustrates an area possessing distinctive geological features. Little has hitherto been done in this direction. The mineral department of the Natural History Museum possesses a large and extensive collection of foreign and Colonial lithological specimens arranged according to localities, which is too little known, but it is naturally very unequal and incomplete, some countries being comparatively well represented and others scarcely at all. The geological department of the museum is well provided with palæontological specimens, but these are arranged according to their biological affinities, and they might well be supplemented by a series of typical collections illustrating the fauna and flora of the more distinctive horizons in different areas. This is all the more important, as the mode of preservation may be very different in different places. The provision of such facilities for the study of the geology of other lands is especially desirable in London in view of the number of students of mining and economic geology who receive their training in this country and ultimately go out into the world to find themselves face to face with problems in which a true understanding of the local geology is absolutely essential.

* * * * * *

It is more difficult to arrive at the true interpretation of the phenomena presented by the endogenetic rocks[5] which have come into existence by the action of the forces of the earth's interior, for the conditions of temperature and pressure under which they were formed, whether they are igneous rocks in the narrower sense, or mineral veins, or metamorphic in

[4] Even the number of skilled mechanics is quite insufficient, though their work is urgently needed. In the Geological Department provision is made for two only, and at present but one is actually at work.

[5] T. Crook, *Min. Mag.*, vol. xvii., p. 87, 1914.

origin, were widely different from those with which we are familiar. In such circumstances the ultimate physical principles are the same, but the so-called constants have to be determined afresh, and a new chemistry must be worked out. It is necessary, therefore, so far as possible, to reproduce the conditions that prevailed—a task which has been courageously undertaken and, to a considerable extent, accomplished by the geophysical laboratory of the Carnegie Institution of Washington.

By artificial means temperatures and pressures have been already produced far higher than those that were in all probability concerned in the evolution of any of the rocks that have been revealed to us at the surface by earth-movements and denudation, for it is unlikely that in any case they were formed at a greater depth than five or six miles, corresponding with a uniform (or, as it is sometimes termed, hydrostatic) pressure of 2000 or 2400 atmospheres, or at a greater temperature than 1500° C. Indeed, it is probable that the vast majority of igneous and metamorphic rocks, as well as mineral veins, came into existence at considerably less depths, and at more moderate temperatures. It is true that most of the rock-forming minerals crystallise from their own melts at temperatures between 1100° C. and 1550° C., but they separate out from the complex magmas from which our igneous rocks were formed at lower temperatures.

It has been found possible at the geophysical laboratory to maintain a temperature of 1000° C. or more under a uniform pressure of 2000 atmospheres for so long a time as may be desired, and, what is equally important, the temperature and pressure attained can be determined with satisfactory accuracy, the temperature within 2° C., and the pressure within 5 atmospheres.

It has been ascertained that such uniform pressure as would ordinarily be present at the depths mentioned does not directly affect the physical properties of minerals to anything like the same extent as the difference between the temperature prevailing at the earth's surface and even the lowest temperature at which igneous rocks can have been formed. It has, however, a most important indirect action in maintaining the concentration in the magma of a considerable proportion of water and other volatile constituents[6] which have a far-reaching influence in lowering the temperature at which the rock-forming minerals crystallise out—in other words, the temperature at which the rock consolidates—and in diminishing the molecular and molar viscosity of the magma, thus facilitating the growth of larger crystals and the formation of a rock of coarser grain. They must also be of profound significance in determining the minerals that separate out, the order of their formation, and the processes of differentiation in magmas.

It is, therefore, obvious that any conclusions derived from the early experiments which were carried out with dry melts at normal pressures must be received with very considerable caution. Nor does much advance appear to have been made, even at the geophysical laboratory, in experiments with melts containing large amounts of volatile fluxes, and yet, if we are to reproduce even approximately natural conditions, it is absolutely necessary to work with magmas containing a proportion of these constituents, and especially water, equal in weight to at least one-third or one-half of the silica present. This will obviously present considerable difficulties, but there is no reason to doubt that it will be found possible to surmount them.

A much more formidable obstacle in realising the conditions under which rocks are formed is the small scale on which our operations can be carried on. There are important problems connected with the differentiation of magmas, whether in a completely fluid or partly crystallised state, under the action of gravitation, for the solution of which it would seem for this reason impossible to reproduce the conditions under which Nature works. Instead of a reservoir many hundreds of feet in depth, we must content ourselves in our laboratory experiments with a vertical range of only a few inches. There are, however, other phenomena that require investigation and that involve a great difference of level in their operation, but do not take place at such elevated temperatures. Such are some of the processes of ore deposition or transference, especially secondary enrichment. Here, with the friendly assistance of mining engineers, but at the cost of considerable expenditure, it might even be possible to experiment with columns several thousand feet in vertical height.

In any attempt to reproduce the processes of metamorphism other than those of a purely thermal or pneumatolytic character, or to imitate the conditions that give rise to primary foliation, we must consider the effects of non-uniform or "directed" pressure involving stresses that operate in definite directions and result in deformation of the material on which they act. Unlike uniform pressure, which usually raises the crystallisation point, directed pressure may lower it considerably and thus give rise to local fusion and subsequent recrystallisation of the rock. At the same time it profoundly modifies the structure, resulting in folds and fractures of every degree of magnitude. One of the most pressing problems of geology at the present moment is to determine the effects of directed pressure in its operation at different temperatures, and in the presence of different amounts of uniform pressure, a factor which has probably an important influence on the result, which must also depend on the proportion and nature of the volatile constituents which are present, as well as on the time during which the stresses are in operation.

The time elements in the constructive or transforming operations of Nature cannot, of course, be adequately reproduced within the short space of individual human activity, or, it may be, that of our race; but I am inclined to think that, even in the case of metamorphic action, the importance of extremely prolonged action has been exaggerated.

In attempting to imitate the natural processes involved in the formation and alteration of rocks and mineral veins, we require some means of ascertaining when we have approximately reproduced the conditions which actually prevailed. It is not sufficient to bring about artificially the formation of a mineral occurring in the rocks or mineral deposits under investigation, for the same mineral can be reproduced in many ways. It is, however, probable that a mineral produced under different conditions is never identical in all its characters. Its habit, or the extent to which its possible faces are developed (a function of the surface tension), the characters of the faces which are present, its twinning, its internal structure, inclusions, and impurities, all vary in different occurrences, and the more closely these can be reproduced the greater the assurance we obtain that an artificial mineral has been formed under the same conditions as the natural product.

For this purpose it is, above all, necessary that there should be in the first place a systematic comparative study of these characters and of the association in which they are found. The results thus obtained should be of the greatest value in indicating the directions along which experimental work would

[6] John Johnston, Journ. Franklin Inst., January, 1917, pp. 14–19.

be most probably successful. They should be supplemented by laboratory studies of the relations of such subsidiary crystallographic characters to the environment in the case of crystals which can be formed under normal conditions of temperature and pressure, and therefore under the immediate observation of the experimenter. Some work has, in fact, already been done on the effects on these characters of the presence of other substances in the same solution.

In the study of the secondary alterations of metalliferous deposits, especially those which consist of the enrichment of mineral veins by the action of circulating solutions, either of atmospheric or intratelluric origin, the study of pseudo-morphs gives, of course, valuable assistance in determining the nature of the chemical and physical changes that have taken place.

The problem of the structure and nature of the earth's interior, inaccessible to us even by boring, would seem at first sight to be well-nigh insoluble, except so far as we can deduce from the dips and relations of the rocks at the surface their downward extension to considerable depths. We can, however, gain important information about the physical condition of the deeper portions from the reaction of the earth to the external forces to which it is subjected, and still more from a study of the "preliminary" earthquake tremors that traverse it, the time occupied in their passage, and the difference in intensity of those that follow different paths. These methods are, however, not applicable to the earth's crust. Its physical characters appear to be distinct from those of the interior, but very little is as yet definitely known about them, except, of course, in the neighbourhood of the surface, and for this reason they are usually ignored in calculating the paths of tremors traversing the earth. It seems to be separated from the deeper portions of the earth by a surface of discontinuity at which earthquake vibrations travelling upwards towards the surface may be reflected. Calculations based on the total time taken by these reflected waves to reach the surface after a second passage through the earth's interior appear to indicate that this surface of discontinuity, whatever its nature may be, is at a depth of about twenty miles, though there can be little doubt that this depth varies considerably from point to point.

There must be numerous surfaces of discontinuity in the earth's crust in addition to that forming its lower limit. Such would be the boundaries between great tracts of granite or granitoid gneiss and the basic rocks that in all probability everywhere underlie them; the surface dividing gneisses and crystalline schists from unmetamorphosed sediments overlying them unconformably; that between hard Palæozoic rocks and softer strata of later age; and the surfaces of massive limestones or sills.

It deserves consideration as to how far it may be possible to add to our knowledge of the earth's crust by experimental work with a view of the determination of surfaces of discontinuity by their action in reflecting vibrations from artificial explosions, a procedure similar to that by means of which the presence of vessels at a distance can be detected by the reflection of submarine sound-waves. The ordinary seismographs are not suited for this purpose; the scale of their record, both of amplitude and of time, is too small for the minute and rapid vibrations which would be expected to reach an instrument situated several miles from an explosion, or to distinguish between direct vibrations and those that may arrive a second or two later after reflection at a surface of discontinuity. As the cylinder on which the record is made would be only in motion while the experiment was in progress, there would be no difficulty in arranging for a much more rapid movement. At the same time it would be desirable to dispense with any arrangement for damping the swing of the pendulum, which would be unnecessary with small and rapid vibrations, and would tend to suppress them. It is possible that it might be better to employ a seismograph which records, like that devised by Galitzin shortly before his death, variations of pressure expressing terrestrial acceleration, instead of one which records directly the movements of the ground. It would, however, probably be found desirable to substitute for the piezo-electric record of pressure employed by Galitzin a record founded on the effect of pressure in varying the resistance in an electric circuit. This is, in fact, the principle of the microphone and most modern telephone receivers, but quantitatively they are very untrustworthy. This would not matter so much for the present purpose, where the time of transmission is the most important feature in the evidence.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

CAMBRIDGE.—Mr. B. M. Jones, Emmanuel College, has been elected to the Francis Mond professorship of Aeronautical Engineering at the University, founded by Mr. Emile Mond in memory of his son, who was killed in the war. This is the first professorship in aeronautics which has been filled in this country. Mr. Jones entered Emmanuel College as an Exhibitioner in 1906. He afterwards became a scholar, and obtained First Class Honours in the Mechanical Sciences Tripos of 1909. From 1910 to 1912 he was employed on aeronautical research at the National Physical Laboratory, and held a research scholarship from the Imperial College, London. In the capacity of an assistant he continued in this work until May, 1913, when he left the National Physical Laboratory to take up the design of rigid airship construction and other aeronautical work for the firm of Sir G. W. Armstrong, Whitworth, and Co. In September, 1914, Mr. Jones joined the Royal Aircraft Establishment, and remained there, carrying out aeronautical research and experimental work until May, 1916. He was then transferred to the Armament Experimental Station, Orford Ness, with the rank of captain, R.F.C., eventually rising to the position of Assistant Controller of Experiment and Research with the rank of lieut.-colonel. His chief activities were directed towards aerial gunnery and aerial bombing, and in order to gain first-hand experience of fighting conditions he qualified as a pilot and served with No. 48 Squadron, R.F.C., in France during the early months of 1916. On being demobilised in March last, Mr. Jones was elected a junior fellow of Emmanuel College, with the post of director of engineering studies at the college.

SHEFFIELD.—The council has received with much regret the resignation of Prof. J. O. Arnold, dean of the faculty of metallurgy and professor of metallurgy in the University since 1889. Steps will shortly be taken to appoint a successor.

DR. J. G. STEWART has been appointed lecturer in engineering at University College, London.

A CHAIR of laryngology has recently been established in the University of Paris, the first occupant of which is to be Dr. Sebileau.

THE sum of 400,000*l.* has been bequeathed to the University of Sydney by Sir Samuel McCaughey.

The University of Brisbane will receive 250,000*l.* from the same source.

PROF. ALEX. FINDLAY desires it to be known that after October 1 his address will not be the University College of Wales, Aberystwyth, but the Chemistry Department, the University, Marischal College, Aberdeen.

THE School of Librarianship, instituted at University College, London, will be opened by Sir Frederic Kenyon on Wednesday, October 8, at 5 p.m. Cards of invitation and particulars of the work of the school may be obtained from the Secretary, University College, Gower-street, W.C.1.

THE programme of University Extension lectures for the coming session has now been issued by the University of London. Central courses are to be held in the University buildings and in the City, while local courses, at some sixty local centres in and around London, will prove of value to the student in the suburbs. The subjects treated cover a wide range, but science occupies a minor position among them. There are to be about ninety courses in all, and these are mainly on literature, economics, history, and architecture, progressive science being represented by two courses only on scientific discoveries and their practical application. Either the local committees of London University Extension centres are not interested in scientific subjects, or the Board is unable to offer a strong panel of science lecturers for their selection.

SOCIETIES AND ACADEMIES.

MELBOURNE.

Royal Society of Victoria, July 10.—Mr. J. A. Kershaw, president, in the chair.—H. G. **Smith**: The essential oil of *Boronia pinnata,* Smith, and the presence of elemicin. The plants were collected at Longwarry, where it grows in great profusion, and the distillation was carried out by Mr. P. R. H. St. John. The product consists largely of elemicin, which has previously occurred only in the order Burseraceæ (Protium, elemi resin), whilst Boronia belongs to the Rutaceæ.—J. T. **Jutson**: The "clawing" action of rain in sub-arid Western Australia. The author describes the erosion on ground generally covered by hard capping due to surface deposits of hard mineral matter. When this capping is broken, miniature waterfalls are formed, and at lower levels basins with crenulated edges, with a gradual reduction of rock material from high to low levels. The "clawing" action of the rills is so marked as to deserve special notice.—J. T. **Jutson**: A striking example of rock expansion by temperature variation in sub-arid Western Australia. This note puts on record an instance of a thin slab of granite parting from the main mass and rising convexly 7 in. from its base before cracking and breaking up.—E. O. **Teale**: The diabase and associated rocks of the Howqua River, near Mansfield, with reference to the Heathcotian problem in Victoria. A study of this interesting area of the Howqua district with its Lower Carboniferous, Upper and Lower Ordovician, and older rocks throws much light on the sequence of the Lower Palæozoic series in other areas. Cherts and bedded ash with radiolaria and sponge-remains are found, similar to those of Heathcote, and an interesting phosphate-breccia with trilobite remains is described, which is closely associated with Upper Ordovician rocks.—F. **Chapman**: An Ostracod and Shell-marl of Pleistocene age from Boneo Swamp, west of Cape Schanck, Victoria. This deposit of marl, which does not now appear to be subject to tidal influence, contains an interesting fauna of fresh- and salt-water Ostracoda, and swamp, land, and marine shells. Two of the Ostracods are new. *Cypris tenuisculpta* and *Limnicythere sicula.* It is probable that in late Pliocene and on to Pleistocene times this area was connected with N.W. Tasmania, as an emergence of Bass Strait of 40 fathoms would show the earliest land connection at these points. This theory is supported by the occurrence of Limnicythere both at Boneo and Mowbray Swamps.

BOOKS RECEIVED.

The English Rock-Garden. By R. Farrer. 2 vols. Vol. i. Pp. lxiv+504+52 plates. Vol. ii. Pp. viii+524+50 plates. (London and Edinburgh: T. C. and E. C. Jack, Ltd.) 3*l.* 3*s.* net.

Motionism, or the World's True Religion. By E. J. M. Morris. Pp. 130. (London: The Caxton Press, Ltd.) 5*s.* net.

Ethnography and Condition of South Africa before A.D. 1505. By Dr. G. M. Theal. Second edition. Pp. xx+466. (London: G. Allen and Unwin, Ltd.) 8*s.* 6*d.* net.

The *Daily Telegraph* Victory Atlas of the World. Part i. (London: "Geographia," Ltd.) 1*s.* 3*d.* net.

The Timbers of India. By A. L. Howard. Pp. 16. (London: W. Rider and Son.) 2*s.* 6*d.*

General Phonetics, for Missionaries and Students of Languages. By G. Noël-Armfield. Second edition. Pp. xii+146. (Cambridge: W. Heffer and Sons, Ltd.) 5*s.* net.

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