Chemistry, Technical

THURSDAY, JUNE 15, 1916.

POSITION AND PROSPECTS OF CHEMICAL INDUSTRY.

RECENT communications to the British and German Press show that already the opposing forces of the trade war of the near future are manœuvring into positions favourable for the prosecution of their militant operations. This contest, when opened, will be most severe in the domain of the coal-tar products, in which hitherto the German manufacturers have maintained a very lucrative monopoly. The German newspapers of the first week in May contain references to an amalgamation of the producers of aniline dyes, drugs, and other fine chemicals. These manufacturers, who have made enormous profits since the outbreak of war, have been impelled to take this step by the fear of foreign, and especially British and American, competition. Seven large chemical factories formerly belonging to three different groups have, while retaining a certain degree of independence, formed a new "community of interests," in which the units will share their "experience," so that all products will be manufactured by at least two of them simultaneously. The strength of this amalgamation is to be gauged, not only by its capital of more than 11,000,000*l.*, but by its unequalled combination of financial, technical, and scientific efficiency.

The advocates of a chemical directorate for chemical factories are met in England with the statement that in Germany the technical directors are only apparently supreme, and that the higher policy is in reality dictated by bankers and financiers. This view is contradicted by *Vorwärts*, which states that the German chemical trust is the only one over which banks and financiers have no control, because this chemical industry has always made such huge profits that it is now supplied with ample funds for extension. The German Press is very optimistic as to the success of the new organisation in maintaining the ascendancy in dyes and fine chemicals of all descriptions. This sanguine anticipation is based on the fact that chemical science has hitherto been treated with indifference in England. The *Neueste Nachrichten* of Munich asks, "Do the English really believe that, by means of customs and patent laws, by waging an economic war, and by boycotting our goods, they can counterbalance German intelligence?" *Vorwärts*, from the point of view of the worker, deplores the formation of the German trust on the ground that a chemist or chemical workman incurring the displeasure of one unit of the group is not likely to find further employment in German chemical industry.

In England the situation in regard to the grouping of coal-tar industries is still obscure, but certain significant developments have recently taken place. The State-fostered organisation has at length admitted a chemist to its board of directors, a step the desirability of which has been repeatedly urged in the columns of NATURE and other organs of the Press. But although British Dyes, Ltd., of Huddersfield, have in the difficult circumstances of the war made commendable progress, it is hard to see how this single organisation can hope to compete with the giant trust of Germany, with its vast resources and accumulated experience. Government help should be forthcoming for all willing workers in this field, and attempts at the boycott and repression of individual firms or chemists should, in the public interest, be rigorously suppressed. The friendly rivalry between Yorkshire and Lancashire, which is a perennial feature of life in the industrial North, is being extended into chemical industry by the recent noteworthy achievements of the firm of Messrs. Levinstein, Ltd., of Manchester. Although excluded from the Governmental favours monopolised by their trade rivals, this firm now claims to manufacture one-half the quantity of dyes formerly imported into this country from Germany. Throughout the war Messrs. Levinstein have supplied the Admiralty and War Office with enormous quantities of blue and khaki dyes, and their colours have rendered possible the equipment of the Belgian and Italian armies with dyed uniforms. The scientific side of this enterprise will be greatly strengthened and vitalised by the appointment to the headship of its research department of Prof. Green, formerly professor of tinctorial chemistry in the University of Leeds, and the discoverer of primuline, dianthine, and other important dyes.

In addition to the two oldest-established firms, many other industrial undertakings are developing extensively in the direction of manufacturing dyes and other coal-tar products. These firms include, not only those in the colour trade before the war, but also munitions factories at present engaged in the production of high explosives, the directors of which are looking to the manufacture of dyes and fine chemicals for a profitable employment of their numerous workers and extensive plants. Finally, there is an increasing tendency on the part of academic chemists to launch out in the direction of preparing urgently needed chemicals, such as dimethylaniline and β-naphthol. Some of these workers are spending time and money on products which are already being successfully manufactured by the larger firms. During the war period the famine in chemicals enables the "small men" to make a profit, even on their necessarily restricted operations. It is, however, doubtful whether these praiseworthy enterprises will be able to withstand the stress of the forthcoming trade war. The collapse of these smaller undertakings will spell ruin to some, and will inevitably entail losses of capital and industrial energy. What is urgently needed at present is an intelligent co-ordination of these useful and patriotic activities.

The question of dyes is only part of the larger problem of coal-tar products, in which Germany has invested a capital of 80,000,000*l*. The cost of producing the best modern synthetic dyes can never in this country be brought to the German level until the utilisation of numerous by-products is placed on a sound economic basis. The solution of this intricate problem demands years of patient and often unproductive research, systematic organisation of chemical investigation, coordination of national resources in men and materials, and extensive industrial development, supported and defended impartially by a scientifically informed branch of the Government.

There is no evidence that anything systematic is being attempted. These sporadic and disorganised enterprises will prove futile against our scientifically organised opponents. Success in this strenuous struggle will come to British chemical industry only if the tactics of the unsupported industrial sniper are replaced by the far-seeing strategy of an organised general staff of qualified chemists and manufacturers.

An important step in this direction was taken on May 23 at a meeting, held at Burlington House, of the representatives of one hundred leading firms engaged in chemical industries, when a motion was adopted to the effect that "it was desirable that British firms engaged in the chemical and allied trades should form an association to promote closer co-operation and to place before the Government the views of the chemical trade generally; to further industrial research; and to facilitate closer co-operation between chemical manufacturers and various universities and technical schools."

At this meeting the chairman, Dr. Charles Carpenter, president of the Society of Chemical Industry, pointed out that at present we had no organisation to meet foreign competition when war was over. Mr. Brunner, M.P., mover of the resolution, stated that, although the war had shown that science was invaluable in time of war, yet the Government, by their lack of knowledge of chemistry, had kept them back in more ways than one.

The opinion was also expressed that this organisation of chemical industries should be regarded as a necessary step in the direction of affiliating chemical manufacturers with a more comprehensive union embracing allied trades. How extensive and diverse are the ramifications of the colour industry will be seen when due consideration is given to the trades affected directly by the abnormal price of dyes. Although textile manufacturers have been hardest hit, the blow has also been felt by paint- and colour-makers, paper-makers, ink-manufacturers, leather-workers, soap-boilers, coach-builders, sealing-wax makers, and the linoleum, celluloid, and engineering trades. If further evidence be needed to emphasise the claim of the synthetic dye manufacturers for impartial and extensive Government support, it is the cardinal fact that this trade is a key industry in the general scheme of national defence. An outstanding example may be cited. One of the large German dye groups was, before the war, employing 10,000 operatives in the production of colours and other fine chemicals. To-day there are 14,000 workers in these factories making high explosives.

LAMB'S HYDRODYNAMICS.

Hydrodynamics. By ~~Prof.~~ ~~Horace~~ Lamb. Pp. xvi+708. Fourth edition. (Cambridge: At the University Press, 1916.) Price 24*s*. net.

THAT this work should have already reached a fourth edition speaks well for the study of mathematical physics. By far the greater part of it is entirely beyond the range of the books available a generation ago; and the improvement in the style is as conspicuous as the extension of the matter. My thoughts naturally go back to the books in current use at Cambridge in the early 'sixties. With rare exceptions, such as the notable one of Salmon's "Conic Sections," and one or two of Boole's books, they were arid in the extreme, with scarcely a reference to the history of the subject treated or an indication to the reader of how he might pursue his study of it. At the present time we have excellent books in English on most branches of mathematical physics, and certainly on many relating to pure mathematics.

The progressive development of his subject is often an embarrassment to the writer of a text-book. Prof. Lamb remarks that his "work has less pretensions than ever to be regarded as a complete account of the science with which it deals. The subject has of late attracted increased attention in various countries, and it has become correspondingly difficult to do justice to the growing literature. Some memoirs deal chiefly with questions of mathematical method and so fall outside the scope of this book; others, though physically important, scarcely admit of a condensed analysis; others, again, owing to the multiplicity of publications, may unfortunately have been overlooked. And there is, I am afraid, the inevitable personal equation of the author, which leads him to take a greater interest in some branches of the subject than in others."

Most readers will be of opinion that the author has held the balance fairly. Formal proofs of "existence theorems" are excluded. Some of these, though demanded by the upholders of mathematical rigour, tell us only what we knew before, as Kelvin used to say. Take, for example, the existence of a possible stationary temperature within a solid when the temperature at the surface is arbitrarily given. A physicist feels that nothing can make this any clearer or more certain. What is strange is that there should be so wide a gap between his intuition and the lines of argument necessary to satisfy the pure mathematician. Apart from this question it may be said that everywhere the mathematical foundation is well and truly laid, and that in not a few cases the author's formulations will be found the most convenient starting point for investigations in other subjects as well as in hydrodynamics. To almost all parts of his subject he has made entirely original contributions; and, even when this could not be claimed, his exposition of the work of others is often so much simplified and improved as to be of not inferior value. As examples may be mentioned the account of Cauchy and Poisson's theory of the waves produced in deep water by a local disturbance of the surface (§ 238)—the first satisfactory treatment of what is called in Optics a dispersive medium—and of Sommerfeld's investigation of the diffraction of plane waves of sound at the edge of a semi-infinite screen (§ 308).

Naturally a good deal of space is devoted to the motion of a liquid devoid of rotation, and to the reaction upon immersed solids. When the solids are "fairly" shaped this theory gives a reasonable approximation to what actually occurs; but when a real liquid flows past projecting angles the motion is entirely different, and unfortunately this is the case of greatest practical importance. The author, following Helmholtz, lays stress upon the negative pressure demanded at sharp corners in order to maintain what may be called the electric character of flow. This explanation may be adequate in some cases; but it is now well known that liquids are capable of sustaining negative pressures of several atmospheres. How, too, does the explanation apply to gases, which form jets under quite low-pressure differences?[1] It seems probable that viscosity must be appealed to. This is a matter which much needs further elucidation. It is the one on which Kelvin and Stokes held strongly divergent views.

The later chapters deal with vortex motion, tidal waves, surface waves, waves of expansion (sound), viscosity, and equilibrium of rotating masses. On all these subjects the reader will find expositions which could scarcely be improved, together with references to original writings of the author and others where further developments may be followed.

It would not have accorded with the author's scheme to go into detail upon experimental matters, but one feels that there is room for a supplementary volume which should have regard more especially to the practical side of the subject. Perhaps the time for this has not yet come. During the last few years much work has been done in connection with artificial flight. We may hope that before long this may be co-ordinated and brought into closer relation with theoretical hydrodynamics. In the meantime one can scarcely deny that much of the latter science is out of touch with reality.

RAYLEIGH.

PREHISTORY IN INDIA.

Madras Government Museum. The Foote Collection of Indian Prehistoric and Protohistoric Antiquities. Notes on their Ages and Distribution. By Robert Bruce Foote. Pp. xv + 246 + plates 64. (Madras: Government Press, 1916.) Price 14*s*. 8*d*.

THIS book must be welcomed, in default of any systematic study of the prehistoric remains. The late Mr. Bruce Foote had, for more than forty years, been collecting stone implements as a bye-issue of his professional work as Government geologist. In 1901 he published a valuable catalogue of the collection in the Government Museum at Madras. Since then he drew up the present catalogue of his own collection, which has lately been added to that museum. The photographic plates here are sufficiently good, and a large map of India (in end pocket) shows seven distinct classes of prehistoric sites by coloured signs. The arrangement by locality is useful for the future worker, but it makes the grasp of the historical results more difficult to follow.

The main question, for which no answer seems forthcoming, is that of the relative and absolute age of prehistory in India. Some assurances given here are surprising, as that in India "the iron industry is one of great antiquity (far greater, indeed, than in Europe—*e.g.*, at Hallstatt or La Tène)" (p. 25). Also that "the iron workers were the direct successors and probably lineal descendants of the neolithic people" (p. 3). Further, that only in "the Later Iron Age we reach a period in which we find Indian man had become acquainted with three additional metals—gold, copper, and tin" (p. 3). We see here a position so different from that of western Asia and Europe that some convincing evidences are needed. Yet, unhappily, there is no stratified site to prove the succession of periods (p. 29), nor is there a single evidence stated of the relative ages. The mention of iron in the Ramayana is quoted, but that is only of the fourth century B.C. No

[1] The fact that liquids do not break under moderate negative pressure was known to T. Young. "The magnitude of the cohesion between liquids and solids, as well as of the particles of fluid with each other, is more directly shown by an experiment on the continuance of a column of mercury, in the tube of a barometer, at a height considerably greater than that at which it usually stands, on account of the pressure of the atmosphere. If the mercury has been well boiled in the tube, it may be made to remain in contact with the closed end at the height of 70 in. or more" (Young's "Lectures," p. 626, 1807). If the mercury be wet, boiling may be dispensed with, and negative pressures of two atmospheres are easily demonstrated.

literary evidence is possible of iron being earlier in India than in Europe, as the oldest works, the Vedas, are, in their present form, centuries later than iron was known in Europe. So far as internal evidence goes the copper axes are closely like those of the copper age in Italy, while the iron tools have much affinity with those of the Roman period. Thus, in the absence of any evidence of position, we are thrown back on the suggestion that the iron is later than that of Europe, and succeeded the use of copper. That stone tools continued in use until iron was made, and so are found contemporaneously with it, is what is known in other countries where copper and bronze long preceded iron, without ousting the use of stone.

It will be seen, then, how the whole basis of Indian prehistory needs clearing up and defining by strict evidence fully recorded. In a land where the wealth of historic buildings far exceeds the provision for archæology, it is a reproach to the Government and not to the archæologist that the prehistory is left unsettled. We need first a firm basis of record of all that is contemporary with finds of Roman coins and early buildings, and before that a series of stages of groups (linked together by their resemblances in pottery, stone, and metal work) which could be projected one beyond the other into the unknown.

Some details will be of general interest. The palæolithic tools are of quartzite, the neolithic of traprock (p. 17). There are no perforated celts (p. 18). The stone axes are set through wooden handles, secured from splitting by iron ferrules (plate, p. 60). Amazon stone is found in veins in granite (p. 23), as in the Egyptian source, the site of which is unknown. W. M. F. P.

WOMEN AND THE LAND.

Women and the Land. By Viscountess Wolseley. Pp. xi+230. (London: Chatto and Windus, 1916.) Price 5s. net.

ONE of the characteristic features of the nineteenth century was the movement from the country to the city, and now in the twentieth century the process is being reversed, and there is a strong tendency to move back once more to the land. As yet it is only in the tentative stages; people go out into the country to retire, to keep a poultry farm, or to set up a fruit farm, and there is much to be learned, and still more to be done, before the movement becomes sufficiently well organised to make it a really potent factor in the national life. It is quite clear that women must take part in it, and perhaps the most notable feature in the whole business is the way in which they are organising themselves for the purpose. We may take it that, once being organised for the exodus, they are not likely to disorganise for the settlement, and the new rural community will therefore be very different from the old. The basis of the women's organisation is educational, and therein it differs from the ordinary man's "back to the land" movement, the basis of which is mainly political. It is this that makes it so full of portent for the future.

Having found the agricultural colleges, with one or two exceptions, barred against them, some of the more enterprising and far-seeing spirits proceeded to set up colleges of their own. Amongst them is Lady Wolseley, who founded the institution at Glynde some fourteen years ago, and in the book before us she sets out the results of her experience and makes various suggestions for the future.

Lady Wolseley does not contemplate that women shall be the labourers, but rather the leaders, in the new community. She considers them well fitted for two classes of work: supervisory or advisory work for educated women belonging to the middle and upper classes; and light manual work connected with the dairy, poultry, bees, fruit, the house, etc., for the village girl. Facilities for training the advisers already exist, but little has yet been done towards teaching the more manual work.

The author maintains, however, that it is not sufficient merely to turn women into the country; some sort of common tie must be kept up, and for this purpose the best arrangement is considered to be a colony on co-operative lines, where it would be possible not only to make good business arrangements for buying and selling materials, produce, etc., but where also opportunities for social life would be afforded. The details are discussed in successive chapters. The most striking feature of the book is the seriousness with which the whole subject is taken, and the clear recognition that a second education is the only sure basis for success. E. J. R.

OUR BOOKSHELF.

The Chemists' Year-book, 1916. Edited by F. W. Atack. Vol. i., pp. 354. Vol. ii., pp. 355–990. (London and Manchester: Sherratt and Hughes, 1916.) Price 10s. 6d. net.

THIS handy book belongs to a type of chemical literature which is more common in Germany than with us. Such examples of it as we have hitherto possessed have been mainly translations from the German, and have been prepared for simultaneous issue in both countries, usually at the beginning of each year. Almanacs and year-books are common enough in all grades of business, but it is only within recent years that they have been adapted to the requirements of professional chemistry. They are essentially designed to meet the wants of practising chemists and public analysts, to whom it is a great convenience to have numerical tables, mathematical constants, and useful memoranda arranged for them in a handy and easily accessible form.

Mr. Atack's compilation is a much more comprehensive production than is usual in a work of this kind, and includes quite a remarkable body of information ranging from a list of notable dates in the history of chemistry to the pharmaceutical names of synthetic compounds and trade names of drugs, together with analytical tables, conversion tables for weights and measures, five-figure logarithms, natural sines and tangents, specific gravity and hydrometric tables, and tables of solubilities of a wide range of substances. As a rule, care has been shown in selecting the latest and best authorities, and the whole has been put together in a convenient form. The proofs have evidently been very well read, as the book is remarkably free from typographical errors. The editor deserves great praise for the thoroughness with which he has done his work, and the book, we trust, will find a place in the laboratory or on the desk of every chemical consultant.

The Purpose of Education: An Examination of the Education Problem in the Light of Recent Psychological Research. By St. George Lane Fox Pitt. New Edition. Pp. xxviii+144. (Cambridge: At the University Press, 1916.) Price 2*s*. 6*d*. net.

FEW people, it is to be feared, even among teachers, ever really face the question: "What ought education to aim at?" This book will at least stimulate to such inquiry, and it points the way in the right direction. The author, accepting the new conception of human personality which psychical research has brought about, considers that the proper purpose of education is the harmonising of psychic phases, the study of the laws governing them, finding their interpretation in the art of living and "giving them synthetic expression in the growth of character." To put the matter in definite form, the manufacture of noble souls is the right aim, and the right method is the inculcation of high ideals. The Sermon on the Mount is the acme of truth and beauty. It urges us to rely less on the seen, the concrete, the physically tangible, and more on the spiritual side of our natures, unmanifest to our senses, but very real and permanent, eternal while the other is temporal. Thus we gain true security and everlasting peace. The present state of Serbia, Poland, and Belgium shows what is the result when education in a neighbour-State becomes materialistic, aiming only at physical efficiency and power. The war has its lessons: we must learn them.

LETTERS TO THE EDITOR.

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

Gravitation and Temperature.

As the outcome of a very delicate systematic series of experiments (*Phil. Trans.*, 1916) it is announced by Dr. P. E. Shaw that "when one large mass attracts a small one the gravitative force between them increases by about 1/500 as temperature of the large mass rises from, say, 15° C. to 215° C."; that is, it increases by about $1{\cdot}2\times10^{-5}$ of itself per degree Centigrade. This seems to be a very startling result, at any rate if temperature is merely the expression of internal molecular motions, as, indeed, Dr. Shaw seems to admit.

By Newton's principle gravitation between masses must act reciprocally; the result, therefore, means that the astronomical mass of a body must increase with temperature by $1{\cdot}2\times10^{-5}$ of itself per degree Centigrade. The pendulum experiments of Bessel and recent determinations by Eötvös seem to establish proportionality between gravitational mass and mass of inertia, irrespective of temperature, well beyond these limits. Thus inertia also would have to increase with temperature; and when a freely moving mass is becoming warmer its velocity must be diminishing, for its momentum must be conserved. A comet like Halley's is heated upon approach to the sun; thus it should suffer retardation in the approaching, and acceleration in the receding, part of the orbit, enough probably to upset existing astronomical verifications. Indeed, as regards change of inertia, we can recall the principle applied by Prof. Joly to the question whether chemical change involves change of mass, viz., that every mass around us is moving through space with the velocity of the solar system, and a sudden rise of temperature in a body must therefore involve a violent kick if its inertia is thereby sensibly altered.

Electrodynamic theory does establish unequivocally an increase of inertia of a body arising from gain (δE) of thermal or electric energy; but this is only of amount $\delta E/c^2$, where c is the velocity of radiation, and so is minute beyond detection. The question whether there is also an equivalent increase in gravitational mass evades discussion until some link connecting gravitative and electric forces has been established.

J. L.

Cambridge, June 5.

A Plague of Caterpillars.

WITH reference to what has appeared in the public Press relative to the devastation caused by caterpillars to the oak trees at Ashtead, you may be interested to know that some three or four years since a similar occurrence took place in the oak plantations in Richmond Park.

The denudation of the trees was so severe that in the spring of 1913 H.M. Office of Works consulted Mr. Maxwell Lefroy, the famous entomologist of the Royal College of Science, with the view of stamping out the pest. Eventually it was decided to spray the trees with chromate of lead at such a time that the young caterpillars, on hatching out, should have only poisoned food. The spraying operations were carried out by portable high-pressure pumping apparatus loaned by myself, self-supporting telescopic ladders being provided to reach the tree-tops some 40 ft. from the ground.

This was, I believe, the first occasion on which attempts were made to spray such large trees, and there is not much doubt that the oaks at Ashtead could be treated in a similar manner.

It is, of course, now too late in the season to undertake preventive measures, but if spraying were undertaken early next May I have not much doubt that the pest could be eradicated.

J. COMPTON MERRYWEATHER.

4 Whitehall Court, S.W., June 7.

The Black-eared Wheatear: A New Bird for the Irish List.

ORNITHOLOGICAL readers of NATURE will no doubt be interested to learn that a black-eared wheatear (*Œnanthe hispanica*) was obtained on Tuskar Rock, Co. Wexford, on May 16, by Mr. Glanville, principal lightkeeper. There are two races of this bird, an Eastern and a Western, each of which exhibits dimorphism of plumage, the throat in some being whitish, in others black. The bird now obtained from Tuskar Rock displays the latter character in its plumage, and is indeed the black-throated wheatear (*Saxicola stapazina*) of earlier writers. When I find time to compare it I hope to be able to assign it to its racial form. In the meantime it seems desirable to announce its occurrence without delay *as a bird quite new to Ireland.* I have to express my great gratitude to Mr. Glanville for so kindly sending me this interesting specimen in the flesh for identification and investigation. C. J. PATTEN.

The University, Sheffield.

EXPERIMENTAL BIOLOGY.

WE use in our title the term Experimental Biology, which requires some apology, as a convenient label for an interesting bundle of thirteen papers by Jacques Loeb and Hardolph Wasteneys. They give an account of important experiments bearing on a variety of puzzling biological problems. (1) Loeb showed many years ago (1889) that some animals orient themselves in relation to a luminous object so that their plane of symmetry falls into the direction of the rays of light, and suggested that this reaction was comparable to the heliotropic reaction of plants. In 1897 he brought forward evidence in support of the view that the action of light in evoking a heliotropic reaction is chemical, and this theory is now confirmed by additional facts.

According to the law of Bunsen and Roscoe, the photochemical effect of light is equal to the product of the intensity into the duration of illumination, and this has been shown to hold for the heliotropic curvatures of plants (Blaauw and Fröschl) and of hydroids (Loeb and Ewald). Furthermore, it has now been shown by Loeb and Wasteneys that the region in the spectrum most efficient in the production of heliotropic curvature is almost the same for hydroids (Eudendrium) and for oat seedlings. The investigators suggest that there are two types of photosensitive substance, one with a maximum sensitiveness (or absorption) in the yellowish-green, and the other with a maximum of sensitiveness in the blue. The first type is represented by visual purple, and a photosensitive substance of this type occurs in Chlamydomonas (often claimed as a plant), in Daphnia, and in many other organisms. The second type of photosensitive substance occurs in Euglena, in Eudendrium, and in many plants. Thus the distribution of the type of substance does not correspond to the boundaries between plants and animals.

(2) In another series of experiments Loeb inquires into the conditions which determine or prevent the entrance of the spermatozoon into the egg. It is well known that a fertilised egg is non-receptive to other spermatozoa. What is the nature of this block? It is not due to the changes underlying the development of the egg, for if the eggs of a sea-urchin are induced to develop by the methods of artificial parthenogenesis, a spermatozoon may still enter the egg or an individual blastomere. By simply altering the alkalinity of the sea-water Loeb can make a sea-urchin ovum receptive or non-receptive to the spermatozoon of a starfish; this depends on some rapid alteration of a physical property of the surface of the ovum. And the ingeniously worked-out experimental argument points to the conclusion that a block of this sort is induced when a spermatozoon fertilises an egg.

But what of the more positive side of the question? There is a widespread belief that a spermatozoon shows a positive chemotropism for the appropriate ovum, but Loeb finds no proof of this in sea-urchins. The motility brings the spermatozoon fortuitously near the egg; the vibrations may assist in boring and in fixing the spermatozoon to the surface of the ovum until other forces, such as surface-tension, come into play. What is certain is that the spermatozoon cannot enter the egg unless physical conditions at the boundaries of egg, spermatozoon, and surrounding solution are right. It must be noted, however, that a sea-urchin spermatozoon becomes more active when it comes near an egg of its own species, and Loeb suggests that this activating effect of the egg upon spermatozoa, being most rapid as regards spermatozoa of its own species, is a means of preventing hybridisation. In other words, the activating influence of the egg has some degree of selective specificity.

(3) In a third set of experiments Loeb tackles the problem of the degenerate condition of the eyes in some cave animals, such as fishes and salamanders. Though a few zoologists cling to the "natural" interpretation that the "blindness," which differs considerably in degree, is due to the hereditary accumulation of the results of disuse, the difficulties in the way of accepting this Lamarckian view are very serious. It has been assumed, therefore, that the blindness of some cave animals began as a germinal variation or mutation. But confidence in the legitimacy of this assumption has been lessened by the meagreness of our knowledge as to the occurrence of variations in the direction of optic degeneration. Very welcome, therefore, are Loeb's recent experiments which show that degeneracy of the eye can be readily induced by influences affecting the condition of the egg or the earliest stages of development. Thus, embryos with degenerate eyes can be produced by fertilising the eggs of *Fundulus heteroclitus* with the spermatozoa of *Menidia*.

Since in these cases there is usually no circulation in the feeble embryos, the inference is suggested that the anomalous condition of the eye may be due to lack of circulation. Blind embryos of the pure breed of Fundulus may be produced by the addition of KCN to the sea-water; and a short exposure of the fertilised ova to temperatures between zero and 2° C. results in abnormal embryos, a certain percentage of which will show degenerate eyes. It is interesting to learn that lack of light does not, in the case of Fundulus, influence the development of the eye. From Loeb's experiments it is not to be argued that the blindness of cave animals arose in any of the ways mentioned. What the experiments show is the legitimacy of the assumption that blindness may arise as a germinal variation or factorial mutation. And that is considerable gain.

(4) Other experiments deal with the influence of balanced and non-balanced salt solutions upon the osmotic pressure of the body liquids of Fundulus; with the functional importance of the ratio of concentration of antagonistic salts with univalent and bivalent cations; and with the membrane formation in the eggs of the sea-urchin.

(5) In an illuminating essay on the stimulation of growth, Loeb states his view that it may be inherent in an unfettered cell to grow and divide eternally in appropriate conditions, as is illustrated, indeed, by both Protozoa and Protophytes. This capacity may depend on the presence of synthetic ferments or "synthetic mechanisms" which are formed from the food taken up by the cells. But few cells show this capacity, and the question rises, What stimulates growth and what keeps the cell at rest? In most cases the unfertilised ovum soon dies, in spite of its potential immortality. If it is fertilised or treated with the methods of artificial parthenogenesis, it divides actively. The condition of rest or activity in this case depends, according to Loeb, upon the condition of the cortical layer of the egg and the alteration in the rate of oxidations connected with this condition. We do not know whether the resting of body-cells is determined by conditions identical with those determining rest in the egg.

We know, however, that specific substances circulating in the blood can induce certain resting cells in the body to grow, and that these substances differ apparently for different types of cells. It may be that in the body substances antagonistic to these may enforce the inactivity of the cells.

(6) In a vigorous and characteristic paper entitled "Mechanistic Science and Metaphysical Romance," Loeb argues that the demonstration of the reality of molecules and the counting of their number in a given mass of matter "puts science for a long time, and probably irrevocably, on a mechanistic basis. It marks, perhaps, the greatest epoch in the history of the theory of cognition. It enables and compels us to define the task of science differently from Kirchhoff, Mach, and Ostwald. We may say it is the task of science to visualise completely and correctly the phenomena of nature, of which our senses give us only very fragmentary and disconnected perceptions. We must try to visualise the numerous hidden processes and conditions connecting the disconnected phenomena we perceive." We cannot argue the question here, but we must be allowed to enter our dissent from Loeb's conclusion that the activities, development, and evolution of organisms can be adequately and exhaustively described in mechanical terms, or in chemico-physical terms (which are regarded by many as ideally mechanical). We are convinced that in living creatures new aspects of reality have emerged which transcend mechanistic formulation. We are inclined to think that further study of the metaphysics which this consummately ingenious experimenter slangs so vigorously might render him less confident in the stability of his mechanistic system. We yield to none in our admiration of his illuminating scientific achievements, but we cannot agree with his philosophy.

J. A. T.

THE GREAT CANADIAN REFLECTOR.

VERY satisfactory progress is being made on the great 72-in. reflecting telescope which is being constructed for the Canadian Government, and is now approaching the final stages of erection and adjusting.

The mounting has been completed by the Warner and Swasey Co., of Cleveland, Ohio, and has been temporarily erected at their factory. Exhaustive tests have shown that the operating mechanism works perfectly. The entire mounting weighs about 120,000 lb., of which the moving parts weigh upwards of 80,000 lb., and yet it moves with the greatest smoothness and ease. The worm wheel for driving the telescope weighs more than 4000 lb., and yet it may be turned readily on its axis with the finger. By means of seven electric motors and conveniently situated stationary and portable switchboards, the instrument can be set, driven, and guided with the utmost facility. Indeed, the immense machine can be operated and handled with greater ease than many small telescopes. The mounting will be taken down and shipped to the observatory as soon as the erection of its dome is sufficiently advanced.

The optical portions of the telescope are being made by the John A. Brashear Co., of Pittsburgh, Pa. The principal part, namely, the great mirror, 73 in. in diameter, is also well advanced. It has been brought to the spherical form, and will be given the paraboloidal form and finally polished as soon as the firm has completed a large plane mirror which is required for testing it. The smaller optical parts are all completed, and have been attached to the mounting. It is hoped that the mirror will be ready as soon as the mounting is erected and in condition to receive it, which will be about the end of the summer.

The pier to support the telescope was completed last autumn. It is made of reinforced concrete, and is of massive construction. The walls of the surrounding circular steel building, 66 ft. in diameter, were erected during the winter, and the dome, constructed by the Warner and Swasey Co., which will rest and revolve upon these walls, arrived in Victoria, B.C., about the end of March, and is now being put in place. The shutter opening is 15 ft. in width. The dome has been very carefully designed to work in conjunction with the telescope, and it is confidently believed that it will be the most complete and convenient of any in the world.

One of the observers' residences has been erected, but none of the other buildings required have yet been begun. It is hoped, however, that everything will be ready to begin regular observing with the magnificent equipment next spring, by which time the preliminary experimental work of adjusting will be completed.

The rapid progress on the telescope is largely due to the excellent plans which were prepared by Dr. J. S. Plaskett in consultation with the Brashear and the Warner and Swasey companies. Dr. Plaskett will have charge of the instrument when completed.

SIR FREDERICK DONALDSON, K.C.B.

AS announced in last week's NATURE (p. 307), Sir Hay Frederick Donaldson, an engineer of distinction, perished in the disaster to H.M.S. *Hampshire,* on June 5, when accompanying Lord Kitchener as a representative of the Ministry of Munitions with the special rank of Brig-General. He held successively the positions of deputy-director-general, chief mechanical engineer, and chief superintendent of the Royal Ordnance Factories, Woolwich. He was associated with, and largely responsible for, the great improvements in the power and mechanism of naval and land artillery during the last twenty years. Since the beginning of the war his energies were severely taxed in assisting to meet the demand for an enormously increased supply of munitions of every description, and in augmenting the productive capacity of the Royal Arsenal. Some months ago he was appointed chief technical adviser to the Ministry of Munitions.

Born in 1856, at Sydney, Sir Frederick was the second son of Sir Stuart A. Donaldson, the first Premier of New South Wales. He was educated at Eton, Trinity College (Cambridge), Edinburgh, and Zurich. He was a pupil of the late Mr. Webb at the L. and N.W. Railway works at Crewe. Afterwards he was executive engineer on the West of India Portuguese Railway and Harbour, engineer-in-charge of No. 1 Section of the Manchester Ship Canal, and engineer-in-chief to the London and India Docks Joint Committee. Then in 1897 he went to Woolwich, where his chief work was accomplished.

In addition to his professional avocations, Sir Frederick took a great interest in the scientific side of engineering. He was a member of the Council of the Institutions of Civil Engineers, Mechanical Engineers, and of the Iron and Steel Institute. In 1913 and 1914 he was president of the Institution of Mechanical Engineers, took an energetic part in guiding its affairs, and delivered an admirable address dealing with the education and the workshop training of engineers. He was actively interested in the work of the Engineering Standards Committee, and was chairman of the committee on screw threads and limit gauges. The investigations of this committee have certainly led to increased accuracy of workmanship and to extensions of the modern system of manufacturing machines with parts interchangeable without needing adjustment. At its instance a lathe of the highest accuracy was installed at the National Physical Laboratory, which can be used in correcting lathe leading screws. In 1909 Sir Frederick gave an instructive lecture at the Institution of Mechanical Engineers on "The Interchangeability of Screw Threads." He also proposed a scheme for the registration of the results of scientific researches carried out in private laboratories and those attached to factories and manufacturing works, with the object of preventing reduplication of effort. Valuable as such a system would be, it has not so far been found practicable.

To great ability and wide engineering knowledge Sir Frederick added unfailing tact and great courtesy and charm of manner, and enjoyed the esteem of all who were associated with him. His colleagues mourn his loss, which to them and to the country is irreparable.

MR. LESLIE S. ROBERTSON.

APPOINTED to the staff as a representative of the Ministry of Munitions, and with the special rank of Lieut.-Col., Mr. Leslie Robertson met his death on the ill-fated mission of Lord Kitchener to Russia. He was born in India in 1863, the youngest son of Sir W. R. Robinson, K.C.S.I., Governor of Madras, who resumed an earlier family name in 1898. He was educated in Germany and at King's and University Colleges in London. He was technically trained in the works of Messrs. Denny and Co., Dumbarton, and Messrs. J. I. Thornycroft, Chiswick. Then he was in private practice for a time, during which he represented in this country the important firm of Normand, of Havre.

In 1901 he became secretary to the Engineering Standards Committee, the work of which he carried on for fourteen years with an enthusiasm and ability to which much of its success is due. Founded initially to standardise rolled sections of steel, the work of this committee has extended to nearly all the materials largely used in engineering, and to a variety of manufactured products from locomotives to glow-lamps. Further, it has standardised tests and specifications. An army of engineers, users, and manufacturers, including representatives of the War Office and Admiralty, formed its sectional committees, giving their services gratuitously, and greatly helped by the tactful arrangements made by Mr. Robertson to economise their time. The results are becoming of increasing importance from an international point of view. In 1912 Mr. Robertson was secretary to delegates sent by the Board of Trade to a congress in New York of the important International Association for Testing Materials, founded by Bauschinger in 1884.

In August, 1915, Mr. Robertson was appointed assistant director of production in the Ministry of Munitions, and was concerned with organising the production of the metal components of ammunition. One of his colleagues at Armament Buildings writes that "his almost unique knowledge of the capacity of the workshops of Great Britain and of the men in charge of them was invaluable in negotiations, leading to the enormous output which has been accomplished. Especially helpful was his knowledge of men and their business capacity, and the Ministry owes much to him in this, not only in the particular section he had in charge, but throughout the organisation."

He was the author of papers on "Propulsion on Canals" and "Light Railways," and translated "Marine Boilers," by M. Bertin, Chief Constructor of the French Navy.

NOTES.

WE learn with deep regret that Prof. Silvanus P. Thompson, F.R.S., died on June 12, a little before midnight, at his residence in West Hampstead, after only two days' illness.

THE meeting of Scandinavian naturalists, to be held in Christiania on July 10–14, will be attended by not fewer than 500 members. The papers announced number 142.

THE Bill to advance legal time by one hour during the period from June 14–15 to September 30–October 1 has been passed by the French Senate and the Chamber of Deputies, so that French time now corresponds to British Summer Time.

THE rescue of the twenty-two members of Sir Ernest Shackleton's expedition who are now marooned on Elephant Island is to be undertaken by a steam-trawler belonging to the Fisheries Department of Uruguay. The vessel was built in Aberdeen in 1906 for the North Sea fishing fleet. She was expected to leave Buenos Aires on June 9, and to call at the Falkland Islands, where she would be joined by Sir Ernest Shackleton, on June 13. They are nearer than South Georgia to Elephant Island, which, if all goes well, should be reached in four days from the Falklands. The trawler has been fitted with wireless apparatus, and communication will be maintained with her by a British auxiliary cruiser, which will be stationed in Drake's Strait. It is therefore possible that news of the rescue of Wild and his comrades may be received on June 18, and the party may be back in South America before the end of the month. With regard to the Ross Sea, the Secretary of the Admiralty announces that the rescue of the men left ashore when the *Aurora* was blown away from her winter quarters at Cape Evans will be carried out at the end of this year in the *Aurora*, with the co-operation of the Governments of the Commonwealth of Australia and the Dominion of New Zealand.

WE regret to learn that among the officers killed in the naval action in the North Sea on May 31 was Commander H. L. L. Pennell, R.N., who lost his life by the sinking of H.M.S. *Queen Mary*. Commander Pennell, who was thirty-four years of age, joined the *Britannia* in 1898, and became a midshipman next year. In 1903 he was promoted lieutenant, and after several years' distinguished service was selected by the late Capt. R. F. Scott to be one of the officers of the *Terra Nova* in the British Antarctic Expedition of 1910. When Capt. Scott and the main wintering party had landed in McMurdo Sound early in 1911, Lieut. Pennell took the *Terra Nova* east, along the Ross Barrier, and found Amundsen in the *Fram* at his winter base. Lieut. Pennell afterwards landed the second wintering party at Cape Adare, and in the following summer moved them further south. He was in command of the *Terra Nova* throughout the expedition, and it was he who, on the return to New Zealand, discovered the westward trend of the north coast of Victoria Land, which he named Oates Land. On his return from the Antarctic in 1913 Lieut. Pennell was promoted commander in the Navy.

THE *Morning Post* of June 5 contains some of the impressions of life in Germany, particularly of the scientific activity, received by a neutral lately returned from Berlin. The general view of the greater scientific efficiency of Germany is confirmed, and the German interest in science as a source of profit is contrasted with the study of science for its own sake in this country. We learn that German chemists introduced a gaseous arsenic compound for military use which could be fired into the enemy ranks in cases which exploded on arrival. Fortunately, however, for the Allies' troops, the gas decomposes and becomes innocuous when fired from a gun. The manufacture of synthetic rubber (particularly for motor-car tyres) is said to be a great success, but the process is a competitor with the manufacture of explosives for the limited supply of benzol. The neutral observes that the scientific experiments with bread have been less encouraging, its quality having become worse, whilst the indigestible portion has increased in amount this year. The people are suffering privations from insufficiency and poverty of food, the effects being loss of weight and an illness caused by unwholesome diet. Great hopes are reposed in the coming harvest, towards the abundance of which science has done its share by providing nitrates manufactured from atmospheric nitrogen.

IT is worthy of note that the Addington-Wickham bourne is now flowing, a phenomenon of very rare occurrence. The last flow of any magnitude was in 1883, when more than three million gallons of water per day were gauged by Mr. Baldwin Latham near Hayes. Since that date two water pumping-stations have been built in this valley, the combined pumping of which has resulted in the present bourne being reduced to 1,600,000 gallons a day, as measured recently by Mr. Latham. The bourne is interesting as being essentially the highest source of the Ravensbourne. It now commences in springs in a field near to Addington village. Many springs can be seen feeding it in the fields in the valley, and it has filled up two large gravel pits near the Hayes railway. It passes under the railway and, crossing the road, reaches what for many years has been the source of the Ravensbourne. The present source, although now on the chalk, has to well up through a considerable thickness of gravel. It is surmised that in times when the Croydon and other bournes are out, this one remains invisible owing to its flowing over the chalk but under the gravel, and only on exceptional occasions it appears at the surface. It would seem that a good deal of underground solution is going on, judging from the manner in which the banks around the spring-heads have been let down below the surrounding levels.

THE "Report of the Committee on Edible and Oil-Producing Nuts and Seeds" of West Africa [Cd. 8247], just issued, affords an interesting glimpse of the changed attitude of the Government towards science and industry, brought about by the war. The exports of oilseeds and oils from British West Africa in 1913 were valued at 7,228,000*l.*, and of this amount Germany took no less than 3,869,000*l.*, chiefly in the form of palm kernels, the crushing of which for oil and cake she had practically monopolised. The outbreak of war placed British West African exporters in a serious position, the usual channel for more than half their exports of oil and oilseeds being stopped. The story of how this difficulty was met and a new British industry in the crushing of palm kernels organised is told in Prof. Dunstan's introduction to

"Oil-seeds and Feeding-Cakes" (London: John Murray, 1916), and need not be repeated here. The action taken was so successful that when the Oilseeds Committee began its investigations in June, 1915, it was in the fortunate position of merely having to consolidate an industry instead of having to create one. Full justice is done in the report to the work of the Imperial Institute, the British agricultural colleges, and the Board of Agriculture, all of which took part in the scientific, technical, and commercial investigations which led to this successful result. The Committee makes four recommendations with a view to the retention of the new industry in British hands after the war, and of these two are to be put into immediate action, in accordance with instructions contained in a despatch from Mr. Bonar Law to the Governments of Nigeria, Gold Coast, and Sierra Leone, printed with the report. The first of these is the imposition of an export duty of 2*l.* per ton, or more if necessary, on all palm kernels exported from West Africa to ports outside the British Empire. The second recommendation is that the West African Departments of Agriculture and Forestry should take measures to continue and extend their investigations of the oil palm, and that "these measures should be taken in co-operation on the scientific and technical side with the Imperial Institute, by which admirable work has been done in the past in connection with the oil palm, and to which much of the existing knowledge of the palm and its economic products is due."

THE care expended on the well-being of the animals in modern zoological gardens is well illustrated in the forty-fourth annual report of the Zoological Society of Philadelphia, which we have just received. As in the Gardens of the Zoological Society of London, the most searching post-mortem examination is instituted in the case of every death, and as a result discoveries are made the importance of which is not to be measured by their immediate value to the society concerned. In the present report the most interesting items are a mysterious epizootic among the waterfowl, and of an arachnoid parasite in the lungs of monkeys. The lesions they produce simulate, and may be mistaken for, tubercles. But their presence does not seem seriously to affect the host. The original habitat and mode of transmission are unknown, but no fewer than four different species have been described, and have been taken from monkeys both in India and Africa, as well as from captive specimens.

DEAD bodies of the short-tailed petrel, to the number of many hundreds, have periodically been found along the beach at Ulladulla, New South Wales, and a like mortality prevails on some islands a few miles off the mainland. Naturally such discoveries have given rise to much speculation among ornithologists. As a rule it is attributed to disease, starvation, or storms. But Mr. G. Basset Hull, in the *Emu* for April, advances what seems to be a much more probable explanation—to wit, that these are the victims of the struggle for breeding territory with the larger and more powerful wedge-tailed petrel. Support is lent to this view from the fact that on one island, where the wedge-tailed species were breeding in large numbers, no burrows were found tenanted by the short-tailed species, but their dead bodies were found outside the burrows of their larger rivals. If, indeed, the smaller species is harried, buffeted, and finally driven off in an exhausted state by the larger, then the struggle for existence in the case of the short-tailed petrel must be indeed severe. It is to be hoped that an attempt will be made to set this matter at rest, for it raises a point of quite exceptional interest.

IN the *Australian Zoologist* (vol. i., part 3) Dr. A. S. Le Souef, the director of the Zoological Gardens, Sydney, records some interesting colour variations of opossums of the genus Trichosurus. The general coloration of the common opossum (*Trichosurus vulpecula*) is grey above, whitish below. The variants on this are rufous, black, and fawn, but it seems difficult to associate such variations with environmental conditions. Thus "brown" coloured individuals are most common in Tasmania, and appear to be confined to the moist, heavily timbered districts; but on the mainland brown-coloured specimens are very common, "particularly in the drier districts." The descendants of the Tasmanian opossum turned out at Lyttelton, New Zealand, some five and twenty years ago already show variation from the typical form, since the animals have become darker and the fur longer and less dense. The author suggests that Mr. Oldfield Thomas, of the British Museum, was in error when he described the mountain opossum (*T. caninus*) as brown in colour. This hue appears only in the black opossum after it has been partially depigmented by immersion in spirits. The existence of the black opossum is here recognised for the first time, being designated a distinct subspecies (*T. caninus nigrans*). This well-marked subspecies "is found in the heavy coastal scrubs in north-eastern New South Wales and southern Queensland."

IN the report of the South African Museum for 1915, just issued, Dr. L. Péringuey, the director, relates a very extraordinary occurrence. While the troops of the Union were camped in the wide sand-belt of Luderitzbucht and Swakopmund, waiting to advance inland, there appeared, suddenly, after heavy rains—a thing almost unheard of in those parts—all along the line, immense swarms of moths. The fact is the more extraordinary and mysterious since these sands are almost void of visible vegetation. That they were brought by the wind from inland Dr. Périguey considers improbable. They disappeared as rapidly as they came. Samples which were sent to the museum proved to consist of no fewer than twenty species of Noctuidæ. In this report mention is also made of the fossilised skull of the "Boskop" man found in the Transvaal, and of fragments of limb-bones, probably of the same skeleton. This skull, which seems to be remarkable for its great length, has not yet been described in detail. It is much to be hoped that this will soon be done. A mandible found in the river-gravels at Harrismith, in the Orange Free State, and stone implements found in another locality in the Orange Free State, are also mentioned among the acquisitions for the year deserving special mention.

IN an article under the title "The Reflex as a Creative Act" (Bull. Imp. Acad. Sci., Petrograd, November, 1915), the eminent Russian biologist S. I. Metalnikov discusses the nature of reflex action, and contests the position of those biologists and physiologists who maintain (*a*) that reflex action presupposes the existence of a central nervous system; (*b*) that reflexes are unconscious and involuntary; (*c*) that they are uniform and invariable. If, he says, we concede these premises we are at the outset brought up against a whole series of difficulties. In many of the lower Invertebrata, and in all unicellular organisms, the most careful research fails to reveal any central nerves, yet they react to various stimuli no less than the higher organisms. Further, we can never determine by direct observation whether a reaction is voluntary or involuntary. And, lastly, even as no two organisms are exactly alike, so there are no two absolutely similar reactions. The reactions of Protozoa are never uniform. Even in Amœba they are so varied as to be scarcely ever twice alike. After describing some experiments on Paramœcium, the author maintains that every reaction produces a definite modification in the living tissue, and may therefore be considered as closely connected with the creation of the personality, and he concludes a closely reasoned dissertation in these words:—"The life of every organism is an uninterrupted creation, and this individual creation, the cause of endless variety, is but a small part of that larger creative cycle which we call evolution."

DR. JOHS. SCHMIDT, in vol. xxiii. of *Rapports et Procès-verbaux du Conseil International pour l'exploration de la mer*, gives a further contribution of his studies on the natural history of the eel. The paper deals with the question of the existence of "smaller species" or "races" of the European eel, and with the distinguishing features of this species, of the American and of the Japanese eel. The characters investigated include the number of vertebræ, the number of rays in different fins, and the number of branchiostegal rays. The conclusion arrived at is that, whilst the three species investigated are clearly marked the one from the other, it has not been found possible to distinguish between different "races" of the European eel. The most convenient character is the number of vertebræ. The author brings forward a point of considerable biological interest by comparing the condition found amongst the eels with that found in the viviparous blenny (*Zoarces viviparus*), a species having about the same number of vertebræ as the eel. He finds that samples of Zoarces taken from closely adjacent localities in Danish waters may differ one from another as regards number of vertebræ to a higher degree than does the European eel from the American eel in respect of the same character, and that, whereas *Zoarces viviparus* in the north of Europe is divided up into numerous distinctly different stocks or populations according to locality, all the eels of Europe are identical. This difference the author considers must be due to the fact that all European eels have the same origin in the spawning grounds of the Atlantic Ocean. The blenny, on the other hand, is viviparous and has no pelagic stage, so that it is highly localised, and specimens collected, for instance, in the inner waters of a fjord may have a lower number of vertebræ than those taken at the mouth. Whether this is due to "genotypic differences" or to the immediate effect of varying external conditions, the author hopes to make a matter of direct experiment.

THE Government of Madagascar has issued the "Annuaire Général de Madagascar et Dépendances" for 1916. The war has affected the size of this year's volume, which takes the form of a supplement and corrections to the issue for 1914. Among a great deal of matter the most useful from a geographical point of view is the account of the railways, to which is added a large-scale map. There is also a short account of the chief roads, and of the navigable waterways. The last part of the volume is occupied with trade statistics.

VOL. 1 of Agricultural Statistics for India, 1913–14, which deals with British India, demonstrates a noteworthy steadiness of agricultural operations during recent years. In the preceding decade the total area cropped, the areas sown with rice, millets, wheat, sugar, cotton, jute, and oil-seeds, suffered but slight fluctuations. The cropped area which has been irrigated and the area devoted to food crops have both increased, the former by 30 per cent. In the whole of India 80 million acres are sown with rice, which is ten times the acreage in Japan; 29 million acres with wheat, which is only exceeded by the wheat acreage of the United States; and 25 million acres with cotton, which is two-thirds of the cotton acreage of the United States. About one-eighth of the Indian area is cropped more than once. The exceptions to the general conditions are indigo and opium, which have declined in acreage by about a half since 1909. In the latest year the area devoted to cinchona was increased by a tenth; this increase is due to a great extension of the cultivation in Bengal, the acreage having declined in Madras, which is the other chief growing district. Nearly half the sugar-cane is produced in Agra, where the area under this crop is being increased. A third of the cropped area in Madras and the United Provinces, a half in the Punjab, and three-quarters in the district of Sind depend upon irrigation from canals, tanks, or wells for their water supply.

THE fifth volume of the special reports on the "Mineral Resources of Great Britain" has just been issued by the Geological Survey (London: H.M. Stationery Office and E. Stanford, Ltd.; price 1s.). This is rather more miscellaneous in scope than its predecessors, and deals with a number of mineral substances between which there is neither economic nor geological relationship, namely:—Potash-felspar, phosphate of lime, alum shales, plumbago, molybdenite, chromite, talc and steatite, diatomite. It will be noted that some of these substances, like alum shales, are being worked to-day; others, like plumbago, have given rise to important mining operations in the past; and others again, like molybdenite, never have been worked in this country, nor does there seem to be much probability as regards this mineral that workable deposits are likely to be discovered. It might be suggested that in such a case as the last-named rather more attention might be devoted to the known occurrences within the Dominions of Greater Britain. The first article in the volume is perhaps the most interesting, because the discovery of an economically workable British source of potash is one of the great needs of the moment. It is curious to note that in the section dealing with the extraction of potash from felspar foreign authorities are freely quoted, but no reference is made to an exhaustive recent article on the subject in the Journal of the Society of Chemical Industry (April 30, 1915). If the present work serves to direct the attention of chemists and geologists to this important subject, nothing but good can result; indeed, it seems strange that, at a moment when committees by the score are being created to advocate researches into all manner of subjects, some of them, perhaps, of but remote practical interest, the important question of potash supply has not received more attention. It would indeed be a wise move if the Board of Agriculture would offer a handsome prize as an inducement to chemical investigators to work at this problem, which, although admittedly difficult, should not be incapable of solution.

AN interesting addition to the existing literature on the eruptions of the volcano Stromboli has come to our notice in the form of a collection of papers published in a particularly interesting number of the *Atti dei Lincei*, xxv. (1), 5. It was after an interval of twenty-four years that an eruption characterised by copious flows of lava made its first appearance in June, 1915, and Prof. Gaetano Platania and Prof. Gaetano Poute were deputed to study the phenomena, being assisted in this work by an American vulcanologist, Mr. F. A. Perret. The papers here referred to describe separately the individual experiences of the three observers, Profs. Platania and Poute contributing their own observations, while those of Mr. Perret are detailed in a paper by Prof. A. Riccò.

ALTHOUGH figures of equilibrium of rotating liquids have already been fairly thoroughly studied by the late Sir George H. Darwin and others, a fresh method of approximate solution of the problem, by Prof. A. Liapounoff, appears in the Bulletin of the Petrograd Imperial Academy of Sciences, vi. (April 15). The principal feature of this method is that, after obtaining an equation which is not in itself soluble, the author substitutes an approximate formula, which may be taken as equivalent to the previous one to a sufficient degree of accuracy within the limits involved in the calculation and overcomes the mathematical difficulties.

THE May issue of Section A of the Proceedings of the Royal Irish Academy contains three papers by Prof. McClelland and his assistants which deal with methods of production and detection of ions in the atmosphere. In the first of the series it is shown that leaves exposed to the ultra-violet light of an electric spark between aluminium electrodes show the photoelectric effect to an extent which in some cases is a tenth of that shown in the same circumstances by copper. A cold-water extract from the leaves may show an activity a third of that of copper, while an acetone extract shows no activity. A few drops of the acetone solution will, however, render a large volume of water strongly active. The other papers relate to the ions produced when water is sprayed into air or air bubbled through mercury. In both cases the saturation curves of the air show that there are four or five kinds of ions present in it with mobilities which vary from those of the large Langevin ions to those of the ordinary small ions, while there appear to be present in addition at least two types of ions with still greater mobilities.

A VERY timely and valuable essay on "Zinc, its Production and Industrial Applications," by Mr. J. C. Moulden, was recently read in abstract at a meeting of the Royal Society of Arts. This essay was the result of a prize founded by Mr. Reginald Le Neve Foster in memory of his father, a former secretary of the society from 1853 to 1879, the subject being determined by the council. The publication is one of considerable length, and extends over two weekly issues of the society's journal. It opens with an account of the physical and chemical properties of the metal, and then passes to a consideration of its history, from which it appears that although it played no part of any importance in the economics of the ancients it was known to them both as the metal and in the form of alloys. The first zinc smelting works were established in this country at Bristol in 1743 by John Champion. He also secured a patent in 1758 for the winning of brass and zinc from blende as a substitute for calamine, which hitherto had been the sole source of the metal. Succeeding sections deal with zinc ores, their nature, occurrence, and distribution, and the metallurgy of the metal. The essay should be of great service, appearing, as it does, at a time when the possibility of establishing a great zinc industry in this country is being carefully considered.

THE U.S. Bureau of Standards has recently issued a circular (No. 58) entitled "Invar and Related Nickel Steels," which is mainly a compilation from sources, many of them inaccessible, as to the properties of nickel steels, with particular reference to the properties of the non-expanding alloy known as "invar." This should prove to be an exceedingly useful publication. After a brief historical introduction the following properties receive attention: (*a*) Reversible and irreversible nickel steels, their equilibrium diagram, microstructure, and constitution. (*b*) Magnetic properties. (*c*) Electrical properties. (*d*) Thermal expansion. (*e*) Transitory length variations following temperature changes. (*f*) Permanent changes in length at constant temperature. (*g*) Elongation of invar with time. (*h*) Rapidity of invar transformations. (*i*) Effect of composition on instability. (*j*) Reproducibility of properties of invar. (*k*) Density. (*l*) Mechanical properties. (*m*) Resistance to corrosion. (*n*) Applications, sources of supply, and bibliography. The knowledge of ferro-nickels goes back to the year 1822, when Stodart and Faraday published a paper. It was in 1889 that James Riley, of Glasgow, described, before the Iron and Steel Institute, his epoch-making investigation which disclosed the remarkable mechanical properties of nickel steels. His alloys contained various amounts of nickel up to 49 per cent., which had been prepared for him in France by Marbeau. The above circular may be obtained free by addressing a request to the Bureau of Standards.

OUR ASTRONOMICAL COLUMN.

COMET 1916*b* (WOLF).—The following ephemeris is a continuation of that given in NATURE of June 1 for Greenwich midnight:—

	R.A. h. m. s.	Decl ° ′
June 21	12 29 31	+4 45·4
25	30 14	4 44·2
29	31 10	4 41·6
July 3	32 18	4 37·6
7	33 39	4 32·3

Correction.—The comet's distance on July 3 will be 400 million miles, *i.e.* ten times the figures given by error in the note referred to above.

THE SOLAR ACTIVITY.—Another very large, active, spot disturbance has appeared. The following spot has developed considerably since Monday. The larger spot has been seen with ease, using a small glass magnifying five times. Extremely bright faculæ have been noticed (June 13) on the eastern limb.

THE NEW DRAPER CATALOGUE.—The seventieth annual report of the Harvard Observatory contains the extremely interesting announcement that the first step in the formation of the monumental New Draper Catalogue—the classification of the stellar spectra—has been completed. The number of spectra classified is 233,050, covering the entire sky from the North Pole to the South.

THE SPECTRUM OF CORONIUM.—The new red line in the spectrum of the corona, shown by M. Carrasco to be a member of the same series as λ 5303·3, has enabled Prof. Nicholson to extend his analysis of the coronal spectrum to include the six outstanding lines, whence the conclusion is arrived at that the Coronium atom is a simple-ring system with nucleus 7*e*. When it has eight electrons or a single negative charge it emits the lines $\lambda\lambda$ 6374·5, 5303·3, 4566·0, 4359·0, 3642·5, and 3534·0. The lines in the spectra of neutral or of positively charged atoms are found to be situated too far in the ultra-violet for observation (No. 5, Monthly Notices, Royal Astronomical Society).

THE VISIBILITY OF STARS IN DAYLIGHT.—M. Bigourdan's researches in the history of astronomy have brought to light some interesting facts concerning early modern observations of stars in daylight (*Comptes rendus*, No. 22). The earliest record appears to be a note found by Zach among the papers of J. Gaultier, stating that the latter at Aix-en-Provence observed Mercury on March 1, 1611, at 6h. 30m. a.m. —the sun would then be above the horizon. The daylight observation of stars proper appears to date from May 2, 1632, when W. Schickhard first saw Regulus.

GEOLOGY OF SOUTH-WEST AFRICA.

IT is not often that a geological memoir appears in such inspiring circumstances as that issued by the Mines Department of the Union of South Africa on "The Geology and Mineral Industry of South-west Africa" (Pretoria, 1916, price 7s. 6d.). Mr. P. A. Wagner writes with an eye for geographic features and for plant-associations, and his photographic illustrations, such as that of the Okavango River, or that of the noble barchans in the sand-desert, convey vivid information in regard to the new territory of the Union. Here and there in his admirably written text a war that has recently taken place is casually mentioned; otherwise the transference of this rich and developing mineral territory from one Government to another could only be guessed by the quiet excision of "German" from its official name. An exact Dutch translation follows the English text, and the titles beneath the pictures are given in both languages. In a few minutes we find ourselves at home with the simple phraseology of our African comrades, and the memoir will form an excellent lesson-book for mining men travelling out to "Walvis Bay."

Mr. Wagner's description of the geology, accompanied by a remarkable, if provisional, coloured map, shows how the features familiar through the Cape Province stretch beyond the Kalahari region to the coast. Certain shales in the Karroo formation appear, however, to be marine in South-west Africa, and Lower Miocene strata occur in detached areas south of Lüderitz Bay. The composite gneisses of the basal complex are finely illustrated from Diamantberg. In the author's review of the very varied mineral prospects we are glad to note that the Union Government has arranged for the protection of guano-producing birds. The output of minerals so far has been practically confined to the very prosperous diamond-fields of the Lüderitz coast, and the copper ores of the Grootfontein district in the north-east.

Mr. Wagner directs attention to the great explosion which formed the ring of Geitsi Gubib, north of Berseba (Bathsheba). This ring has been recently described by Mr. A. W. Rogers (Trans. Roy. Soc. S. Africa, vol. v., p. 247), who shows that, contrary to Dr. Schenck's opinion, volcanic rocks are not to be found in its materials. The "breccias" and tuffs are formed mainly from shattered sediments, together with some fragments of deep-seated holocrystalline rocks. The central "crater" is merely the result of denudation acting on a softer tuff within a wall of more resisting but equally fragmental matter. The whole mountain is a volcanic neck about a mile and a half in diameter, choked by its products of explosion.

G. A. J. C.

ANTARCTIC HYDROGRAPHY.

MANY of the scientific results of the *Scotia* Antarctic Expedition (1902–04) of Dr. W. S. Bruce have now appeared, but want of funds has seriously delayed the publication of the valuable observations. The Royal Society of Edinburgh, which has done a great deal to further the publication, has issued in its Transactions (vol. li., 4, pp. 71–170) a lengthy memoir on the temperatures, specific gravities, and salinities of the Weddell Sea and of the North and South Atlantic Ocean by W. S. Bruce, A. King, and D. W. Wilton. The surface observations were taken daily by Mr. Wilton from the beginning to the end of the expedition, except during the wintering of the *Scotia* at the South Orkneys, and extend from the North Atlantic to the Weddell Sea *viâ* the Falkland Islands, and home *viâ* Gough Island and Cape Town to St. Helena and the Azores. In Antarctic waters observations were generally taken every four hours, and sometimes oftener. In addition, many readings were taken at depths down to 3000 fathoms.

Dr. Bruce recounts the minute care exercised in taking the observations, which deal with nearly six hundred samples. The densities were determined by hydrometers lent by Mr. J. Y. Buchanan. Deep samples were obtained by the Buchanan-Richard water-bottle. Occasionally the Pettersson-Nansen insulated water-bottle with the direct-reading Richter thermometer was used, but for polar work this has its drawbacks, quite apart from its excessive cost and the liability of loss in bad weather. The fine screws are difficult to manipulate with cold fingers, and it is questionable whether the insulation is trustworthy at low air temperatures. In one case the contents were frozen solid when the bottle came on deck. On the other hand, the Buchanan-Richard bottle is cheap, easily manipulated, does not jam by freezing, and is trustworthy at any depths. Nor is it probable that errors are frequent or large due to variations in the point at which the mercury breaks in the reversing thermometer. In the case of every sample, in addition to the data relating to collection, those in relation to the determination of its density are given. The density is given (1) at the temperature of the experiment, (2) at 15·56° C., (3) at the temperature of the sea at the time the sample was taken. This last gives the actual density of the water *in situ*. Some of these calculations are the work of Mr. A. King, and all the others have been checked by him. Exigencies of space and expense have prevented a full discussion of the results and the addition of charts, but, nevertheless, the memoir constitutes the finest contribution ever made to Antarctic hydrography.

PORTLAND CEMENT.

PORTLAND cement has in recent years come into such extensive use for a variety of purposes that particulars concerning it should interest a wide circle of readers. In vol. lix. (part iii., January, 1916) of the Transactions of the Institution of Engineers and Shipbuilders in Scotland, appears a paper by Mr. B. J. Day on the manufacture, properties, and testing of Portland cement, with a special description of a cement works erected by the author at Aberthaw, Glamorganshire. This article forms the basis of the following short descriptive account; and by Mr. Day's courteous permission we are able to use two of the illustrations which accompany his paper.

The difference between limes and cements should be clearly understood. Common lime, made by burning pure limestone (composed essentially of calcium carbonate), slakes in water, but has no hydraulic properties (does not harden or set under water). Hydraulic lime, made by burning at a low temperature impure limestones or limestone mixed with clay, slakes on adding water, and has hydraulic properties. Portland cement is made by burning at a high temperature —to incipient fusion of the material—a definite mixture of limestone with clay or shale, and finely grinding the resulting clinker. The powder so obtained has strong hydraulic properties. It is important to distinguish Portland cement from Roman cement and certain other natural cements, and slag cements, all of which are inferior in strength and less constant in composition.

The original Portland cement, patented in 1824 by Joseph Aspdin, of Leeds, was so called because after hardening it looked like Portland stone; but though the composition was similar to that of modern Portland cement, the mixed material was only lightly calcined. Portland cement is manufactured in England, chiefly about the Thames and Medway, Rugby, Leamington, Cambridge, Hull, and the north-east coast, and also in South Wales.

The preparation and mixing of the raw material before burning is effected by the dry process or the wet process. The method known as the semi-wet process is practically the same as the wet process, using less water.

In the dry process the raw material is stored under cover before being crushed, so that the exact amount of moisture may be ascertained and allowed for when mixing lime with the shale or clay. After preliminary crushing in gyratory or jaw-crushers, the raw materials are dried, then weighed, and delivered to the mills in definite proportions. After grinding to an extremely fine powder the mixture is fed into the kiln for burning. In the wet process the material is often delivered in the correct proportions from the quarry into crushers or wash-mills.

On the Thames and Medway, the raw material, consisting of soft chalk and river mud, is washed through fine-meshed sieves, and the "slurry" is then pumped or elevated to the kiln. At Aberthaw, the raw material, consisting of hard limestone and shale, is crushed in jaw-crushers and delivered to the wet mills for grinding with water to a fine slurry.

In the wet process less power is required to grind hard material, and the slurry is easily dealt with by means of pumps; but more fuel is needed in the kiln to burn the slurry than the dry powder in the dry process.

At the Aberthaw cement works are beds of hard crystalline limestone interstratified with beds of shale, all the necessary materials thus occurring together on the spot. The quarrying is done by means of a steam navvy, aided by a small amount of powder to shake the face of the quarry.

The crushed material is ground in vertical mills (chiefly in America), or in horizontal mills (mostly in Europe). Horizontal mills are generally installed in pairs, a ball-mill for preliminary grinding, and a tube-mill as a finishing mill. The tube-mill is much longer than the ball-mill, and contains flint pebbles of various sizes instead of steel balls. The ground material from the ball-mill passes through sieves to reach the tube-mill, the portion retained by the sieves being automatically returned to the ball-mill for further grinding. In the wet process similar mills are employed with only coarse sieves or screens, as otherwise they would tend to get choked.

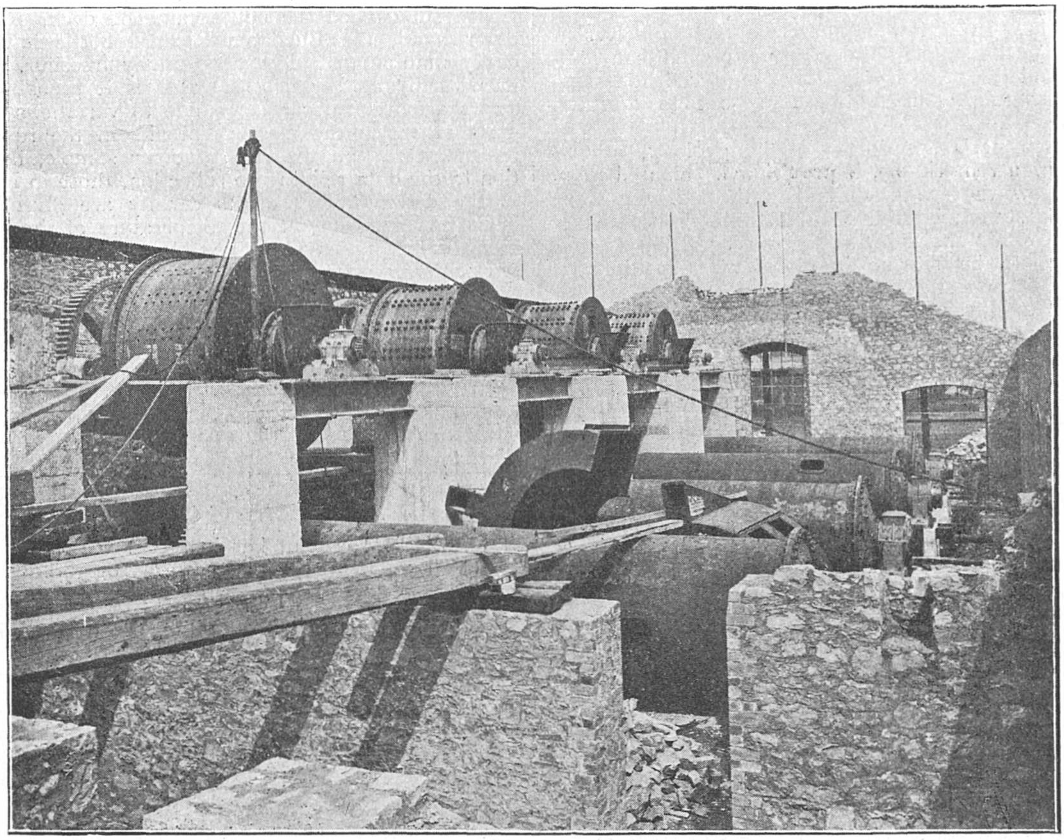

FIG. 1.—Raw-mill grinding-house at Aberthaw during construction, showing arrangement of ball and tube-mills.

At Aberthaw, after leaving the mills, the slurry falls into a trough, and by means of a special conveyer is delivered to two slurry pumps, which deliver the slurry into one of two large storage tanks. The chemist takes half-hourly samples from each mill, and hourly samples from the large storage tanks while being filled. The mixture in the tanks is thus kept practically constant, and is continually agitated.

From the storage tanks the slurry is delivered to the feeding apparatus of the nearly horizontal rotary kilns. Dried, finely-powdered coal-dust is blown into the outlet end of the kiln, and ignites 8 to 10 ft. from the outlet, the temperature in the burning zone being approximately 1370° to 1650° C. This temperature is gradually reduced until at the inlet end it is 315° to 455° C. The slurry is first dried by the hot issuing gases, then water of combination is driven off and organic matter carbonised; the dehydrated clay and lime gradually approaches the clinkering zone, where at 1540° to 1650° C. the combination of the lime, silica, and alumina takes place. The clinker thus formed continues to travel down the kiln and drops into the cooler as a white hot mass of small nodules. As these pass down the cooler the incoming air abstracts heat from the clinker, and thus receives a large part of the heat necessary for combustion. Each ton of clinker burnt requires about 5 cwt. of fuel.

Formerly the shaft or chamber kiln was used, but the rotary type of kiln is now almost universally adopted in modern plants of any size, owing to better burning of the clinker, greater output, and economy.

The clinker is finally ground to an impalpable powder, the grinding arrangements being similar to those for the raw materials. The Aberthaw works produce 2400 tons of cement per week. J. A. A.

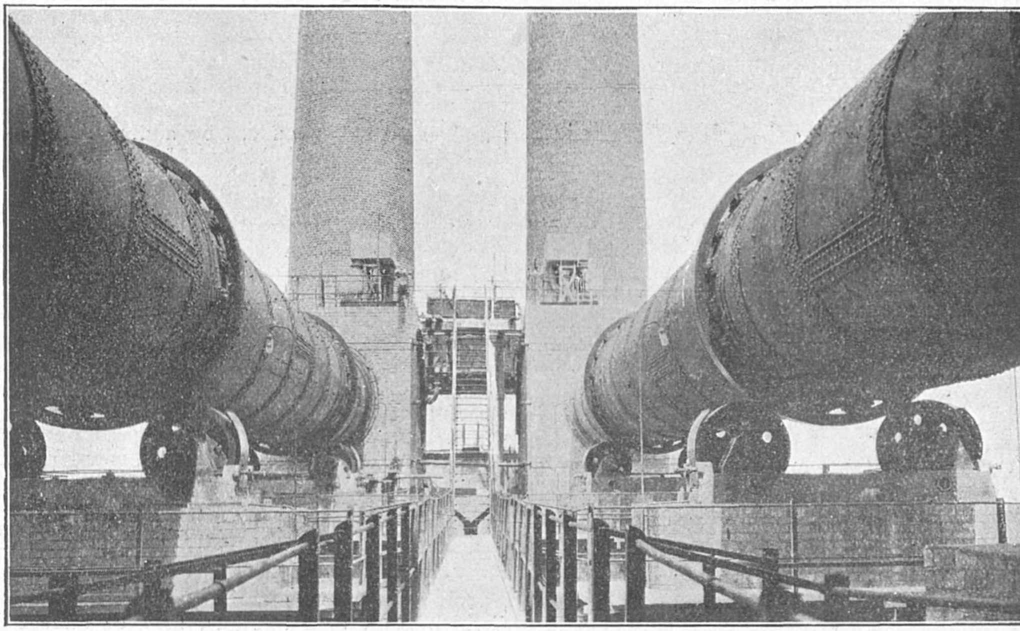

FIG. 2.—View taken from the kiln firing platform, showing the two 200-feet kilns, slurry feed apparatus, dust chambers, and chimneys at Aberthaw.

THE SOIL AND THE PLANT.

NATURE'S CYCLE AND MAN'S CONTROL.[1]

IT is a familiar observation that the upper layer of the soil alone is well adapted for plant growth, the underlying material or subsoil being wholly unsuited for the purpose. But this distinction did not always exist. When the soil was first laid down it was all like the subsoil; something, however, has happened to bring about the change. Observations on land slips and cliff falls, and direct experiments, all show that whenever subsoil is left exposed to the air it begins to cover itself with vegetation, the seeds of which are blown or carried on. The first plants that come up draw some of their food material from the soil, and they build up their leaf and stem tissues partly out of this and partly out of the carbon dioxide in the air. The process requires that energy should be put into it; in this case the energy comes from sunshine, and as neither energy nor matter is ever destroyed in natural processes they are added to the mineral matter of the soil after these plants die, and their leaves, stems, etc., become mingled with it.

Direct experiment shows that this addition of plant residues is beneficial to plant growth, and it is now known that the difference between the surface and the subsoil lies largely in the presence of residues left by generations of plants that have lived and died there. The problem is to find why the plant residues are so beneficial.

These plant residues contain carbon and oxygen in large proportions, hydrogen and nitrogen in smaller proportions, and lesser quantities of phosphorus, calcium, magnesium, potassium, etc. The chief reaction in the soil is an oxidation; oxygen is absorbed and carbon dioxide given out in approximate equal volume. The carbohydrates of the plant disappear very rapidly; some of the cellulose takes longer and gives rise to the black humus familiar to all gardeners. The nitrogen appears as nitrate. This last is not quite what one would expect. In the decomposition of protein as studied in the laboratory the result is always a mixture of amino-acids. Under the action of putrefactive bacteria the decomposition is carried a stage further, yielding ammonia and other bases, but nitrates are not found by the processes of the chemist. At first sight, therefore, the laboratory decomposition appears quite distinct from that in the soil, but close study shows that this is not so. Representatives of the groups isolated in the laboratory can be found in the soil, and, what is still more to the point, if a trace of chloroform or toluene is added to the soil no nitrate is formed, but ammonia accumulates instead. When a trace of untreated soil is added the process starts again, and nitrate is found as

[1] Summary of two lectures delivered before the Royal Institution on February 29 and March 7 by Dr. E. J. Russell.

mold, Vegetable
x Vegetable mold

usual. Thus it appears that ammonia is the precursor of nitrates, and is itself preceded by the usual amino-acids. The distinguishing feature of the soil decomposition is simply that it is carried several stages further.

This decomposition is absolutely indispensable to the plant; the initial products—the proteins—are useless for plant nutrition; the intermediate products are not much good; the ammonia is considerably better, while the final stage—the nitrate—is the best of all.

During this decomposition also, the energy stored up by the plant during its lifetime is run down, so that there is a transformation both of material and energy. Neither the energy nor the material is wasted; they go to support a vast population of the most varied kind, ranging from microscopic bacteria to earthworms. All these depend on the plant residues for their food and their energy. But theirs is no case of taking all and giving nothing in return. Their work is nothing less than the production of food for the plant: preparing new plant food out of old plant residues.

Thus we have a great cycle going on in the soil; dead plant residues mingle with it, and give life to countless micro-organisms, which in turn manufacture

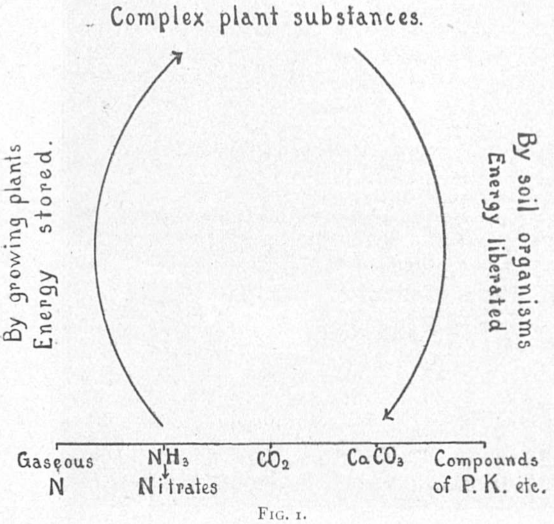

FIG. 1.

out of these residues food for a new generation of plants.

It is necessary to set some limits to the inquiry, and so we restrict ourselves to the production of nitrates. This process is the work of a great number of organisms, some of which carry out the first stages, and others the later stages. It resembles the process of making munitions in that the first stages can be brought about by a large variety of workers, while later stages are much more specialised, and can be effected only by one or two special workers. Indeed, in the wars of the eighteenth century the process was actually under the Ministry of Munitions of the time, and both in Sweden and in Germany elaborate instructions were drawn up for the working of nitrate beds.

The process of nitrate formation is not free from waste; starting with 100 parts of nitrogen as protein, one never recovers 100 parts of nitrogen as nitrate; there is always a loss. But the fault does not appear to be with the special organisms carrying out the last stages of the process, for at least 96 per cent. of the ammoniacal nitrogen reappears as nitrate. It is not clear that it lies with the organisms producing ammonia; at any rate, they can work without loss. The probability is that the loss arises from some of the nitrate that has been actually formed.

However it arises, this loss, as well as the leaching out of nitrate by rain, would in natural conditions bring the stock of soil nitrogen to a very low level if there were no counterbalancing processes, and for the last fifty years chemists and bacteriologists have been searching the soil very thoroughly to find out how these gains are brought about. Two sources are known: the organisms associated with clover and other Leguminosæ, and free-living nitrogen-fixing organisms. These differ very much in appearance and mode of life, but they both require energy for the nitrogen fixation, and this they obtain from the combustion of carbohydrate materials.

It must not be supposed, however, that the organisms bringing about these changes are the only ones in the soil, or that they lead their lives quite independently of the rest of the soil population. Indeed, they could scarcely do so in any case, for there is only a limited store of food and energy, and whatever is not helping is hindering them. Numerous experiments show that there is some factor—neither food, air, water, nor temperature—which is operating to keep down their numbers. As it is put out of action by heating to 55° C., or by traces of volatile antiseptics, and can be reintroduced by adding a little untreated soil, it is presumably biological, and the evidence shows that it consists in part at least of certain amœbæ; it is quite possible that other forms are involved as well. But whatever the detrimental organisms may be they impede the work of the organisms producing plant food in the soil. Fortunately they are put out of action more easily, so that we get the apparent paradox that any process fatal to life (but not too fatal) proves ultimately beneficial to fertility, while any process beneficial to life proves ultimately harmful. Long frost, drought, heat, therefore benefit the useful makers of plant food, while prolonged warmth, moisture, and treatment with organic manures lead to deterioration or to "sickness," as the practical man puts it.

Having thus set out the general nature of the cycle, we next proceed to see how and to what extent it can be controlled.

Control may take place in two directions: the amount of organic matter, *i.e.* raw material out of which plant food is made, may be increased, or the pace of the manufacturing process may be forced.

The necessity for increasing the organic matter in the soil was realised very early. Arable farmers soon found that land cannot be cropped indefinitely; sooner or later it becomes "exhausted"; it recovers, however, if it is left to itself for a time, so that natural vegetation can spring up and die again. The Mosaic law commanded the Jews to leave their land for one year in seven and not to reap "that which groweth of its own accord." The system survived in our own land through Saxon and medieval times; land was uncropped one year in three, two corn crops were taken, then grass was allowed to grow up on the stubble to be ploughed in. The principle still underlies our modern rotations; crops are grown, then the land is left covered with vegetation, but the process is regulated by sowing a definite mixture of grass or clover chosen to make vigorous growth.

Another method for increasing the amount of organic matter in the soil consists in growing a crop exclusively for the purpose of ploughing it in. This also goes back to ancient times: Theophrastus, 300 years before Christ, tells us that beans were grown in Macedonia and Thessaly expressly to be ploughed in at flowering time, and Varro, about 50 B.C., states that lupins were grown for the same purpose. This method is called "green manuring," and even to-day is not so fully developed as it ought to be. Instead of ploughing in the crop it may be fed to animals on the ground; there are other methods also, but the object is always the same.

The cultivator's aim, however, is not to accumulate fertility but to use it. We must therefore turn to the other part of the cycle and see how far the down grade can be controlled. The most obvious method is to try to control the soil organisms. This has proved very difficult, and only the fringe has yet been touched. Soon after bacteriologists had picked out the organisms that cause clover to fix nitrogen they conceived the idea of breeding them in quantity and putting them on to the seed or into the soil, with a view of getting better clover crops, and therefore a greater store of fertility. These hopes were disappointed. Inoculation succeeded only in one case; when a new leguminous crop was introduced it sometimes proved more economical to add the proper strain of organisms than to wait until the native organisms had had time to adapt themselves. This has happened in Scotland, Canada, and the United States. But usually in this country the proper bacteria appear already to be present, and little is gained by adding to their numbers; they merely die down to the proper number the soil can carry. If one wishes to increase the number it is necessary to improve the soil conditions. Even this does not settle the matter, for, as already shown, the soil population is very mixed, and improvements in soil conditions may benefit the whole crowd, bad and good. Indeed, under specially intense glasshouse conditions the harmful population may prosper so much that the efficiency of the soil becomes lowered and the soil becomes "sick." The remedy is obvious: it consists in improving the soil population, and this is done by taking advantage of the fact that the harmful organisms are more easily killed than the useful ones. Steam is used successfully in glasshouses; antiseptics would be cheaper, but in spite of considerable search, nothing has yet been found suitable for field work. The problem is still under investigation.

More success has been attained in the control of soil conditions. Fortunately these are the same for organisms as for plants, so that anything benefiting the one helps the other as well. But there is one fundamental law that always holds; the plant must have all its requirements satisfied or it will fail; for example, no amount of food or water makes up for the lack of temperature. Anything setting a limit to growth is called a limiting factor. Common limiting factors in the soil are sourness, wetness, dryness, poverty, thinness of soil, etc. In soil fertility problems the first step is always to discover the limiting factor, and then to put it out of action.

One of the commonest defects is sourness or lack of lime. From the dawn of history this has been one of the troubles of the Celtic tribes, and before history began they had discovered the remedy. Pliny tells us that they drew chalk out of the earth to "nourish" the soil; to this day the process is still carried out in Hertfordshire much as he describes it. In modern times ground lime is more convenient, and ground limestone sometimes proves even better still.

Wetness can be remedied only in one way—by drainage. This is an old art that was forgotten for a long time; it is not mentioned in the great English agricultural revival of the sixteenth century. Gervase Markham, for instance, wrote books on every branch of farming—so many, indeed, that his publishers made a contract with him to write no more—but never one on drainage. By the middle of the seventeenth century it was well known, though not much practised; by the middle of the nineteenth century, however, it was extensively carried out. Much of it wants redoing. Pipe drainage is out of the question nowadays on any large area, but a cheap and effective substitute seems to be forthcoming in mole drainage, which consists in making tunnels through the soil about 9 to 18 in. below the surface with a special form of plough.

Dryness can either be overcome by adding water, as in the big irrigation schemes, or by taking more care of the natural water supply. Addition of clay or organic matter reduces the loss of water; so also does the preservation of a fine soil mulch on the surface. Implements have been devised to produce this soil layer. Much can be done also by selecting suitable crops or varieties; special drought-resisting wheats have been bred in Australia, and maize in the western States of America.

Shallowness of soil is, however, more serious, especially when the thin soil is underlain by gravel or very coarse sand; indeed, in this case no one has evolved any satisfactory method of treatment. Something may be done if a soft rock lies beneath, and especially if it forms only a thin layer which can be removed. But when all is said and done, there remain great areas of waste land that cannot be dealt with on our present methods.

Apart from these cases, however, a very considerable degree of control of the soil cycle is possible. The question naturally arises: How far can the process go? Not indefinitely. In any scheme of improvement we are soon brought up against the fundamental law that plants must have all their requirements fulfilled, anything lacking setting a limit to their growth. Agricultural investigators aspire to a good deal in the way of control and improvement, but they admit they cannot overcome the weather. Here, then, is one limiting factor which has wrecked many schemes of soil improvement.

Another is the soil type. In spite of all efforts a clay remains a clay and a sand remains a sand. A gardener on sandy soil may with great pains be able to grow clay-soil plants, but they will never "do" as well as if equal care were bestowed on them in their natural habitat. The farmer cannot lavish care on individual plants, but has to deal with masses; he therefore is less able to overcome the difficulties of soil type. This problem, however, is not insuperable, and attempts are now being made to deal with it.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

CAMBRIDGE.—The General Board of Studies has published a report to the Senate on the desirability of instituting degrees, other than the doctorate, to be given for original research; the board is of opinion that the present is a favourable opportunity for instituting a more distinctive recognition of research work than is at present available. Two classes of student have to be considered: first, that composed of graduates of the University; and, secondly, that consisting of graduates of other universities who may, under the present regulations, obtain the Cambridge degree by two years' research work carried out in the University. The Board recommends that the degrees of Bachelor of Letters and Bachelor of Science be established; that a Bachelor of Arts of the University may, in or after his eleventh term, submit for approval a dissertation upon original research for the degree of Bachelor of Letters or Science; that a research student who is not a graduate of the University may submit a dissertation upon original research for one or other of the new degrees after six terms' residence. It is also recommended by the board, although with dissentients, that holders of the new degrees may proceed to the degree of Master of Arts in the same manner as do Bachelors of Arts at present.

Dr. Cobbett and Dr. Graham-Smith have been re-appointed University lecturers in pathology and hygiene respectively.

THE Conference (1916) of the Association of Teachers in Technical Institutions will be held on Saturday, June 17, at 2.30 p.m., in the Lecture Theatre, Day Training College, Southampton Row, W.C. The chair will be taken by the president, Dr. T. Slater Price (military duties permitting), and Dr. W. Garnett will deliver an address. A number of important resolutions referring to technical education, scientific research, and industrial development will be put to the meeting.

ARRANGEMENTS have been made, with the approval of the Foreign Office, for extending to British prisoners of war interned abroad the benefits of the scheme, which has been in operation for the last year in connection with Ruhleben, for supplying selected books of an educational character to those of the interned who may be desirous of continuing their studies in any subject. Under this scheme several thousands of carefully selected volumes, mostly standard works, have been supplied to the Ruhleben Camp, which is now provided with excellent libraries (class, reference, and lending). These books, which have been sent out through the agency of officers of the Board of Education, have proved a great boon to the interned, and have enabled sustained educational work of a definite character to be carried on by the Camp Education Department formed among the prisoners. In view of the value of the work the Board of Trade (Marine Department) have decided to take it into account in connection with their examinations for the certificates of competency granted by them to officers of the Mercantile Marine and the Fishing Service. Accordingly, arrangements have now been completed for recording the time spent by any prisoner interned at Ruhleben or Groningen in the study of nautical or other subjects. An appeal is, therefore, now made for a plentiful supply of new or second-hand books of an educational character (light literature and fiction are available from other sources) to meet the needs of the many thousands of British prisoners interned in enemy or neutral countries. It is to be hoped that to this appeal there may be a liberal response. A circular explanatory of the educational book scheme can be obtained by sending a postcard addressed at the Board of Education, Whitehall, S.W., to Mr. A. T. Davies, who is in charge of the arrangements.

Science for May 5 contains an interesting and suggestive address by Prof. Alex. Smith on "The Training of Chemists," in which the questions of standard and overlapping courses, lecturing, and laboratory facilities are dealt with. Prof. Smith deprecates the very general practice of compelling undergraduates who have studied chemistry at school to take the same course in their first year as those who know nothing of the science. He advocates placing such students in a section by themselves, and finds in his experience that they progress 50 per cent. more rapidly when so segregated. The overlapping which results from the instructor in one branch of chemistry (*e.g.* qualitative analysis) assuming that the student is ignorant of facts and principles which he has already learnt in another branch (*e.g.* the inorganic course) is also emphasised. It is pointed out that, on the other hand, organic chemistry frequently suffers from the fault of being taught as a separate science and not sufficiently co-ordinated with the inorganic branch. Prof. Smith urges that considerable advantage would accrue by the standardisation of the courses in the various branches of chemistry for the different universities and colleges, on account of the facts that migration from one college to another is rapidly increasing, and that colleges of medicine are requiring previous college work. In order that students may acquire that ability to apply theoretical conceptions which will, more than ever, be indispensable in the future, standardising the elementary courses in chemistry is essential. Doubt is thrown on the value of lecturing to elementary students. It is argued that lectures inculcate an ability to understand statements made by others, whereas the object to be achieved is to train the student to make correct statements on chemical topics, and deduce sound conclusions, *himself*, even though these conclusions are not new. Prof. Smith advocates book study of the subject, the class work being restricted to the testing of the work prepared, experiments illustrating the work, the discussion of difficulties, and the asking of questions. He admits the value of lectures to students who know how to study; that is, to those taking the more advanced courses.

SOCIETIES AND ACADEMIES.

LONDON.

Royal Microscopical Society, May 17.—Mr. E. Heron-Allen, president, in the chair.—J. W. **Purkiss**: Some suggestions regarding visual efficiency in the use of the microscope and other optical instruments. From experience of work with the spectrophotometer and other comparative instruments for measuring colour absorptions, the author had arrived at the conclusion that the observer's visual efficiency and accuracy over prolonged periods depend very largely on adjusting the light in which he was working, so that it should be approximate to the light-intensity in the field of the observing instrument. He developed this principle in its application to the microscope and other optical instruments, and showed how the more or less rapid succession of efforts of the eye to accommodate itself to changes of luminosity was usually a much more potent cause of eye fatigue or strain than the actual conditions of light in the field of the instrument itself.—Rev. H. **Friend**: Alien Oligochæts in England.—A. T. **Watson**: A case of apparent intelligence exhibited by a marine tube-bearing worm, *Terebella conchilega*.

Physical Society, May 26.—Prof. C. V. Boys, president, in the chair.—T. **Smith**: The correction of chromatic aberrations when the external media are dispersive. When one of the external media of a lens system is dispersive it is not possible to ensure the absence of differences in the size and position of images of all objects formed by length of different wave-lengths. The degree to which correction can be carried is investigated, and formulæ are given by which the power and position of the external surfaces of a system can be found when the type of correction to be adopted is given.—J. **Guild**: Note on the use of the autocollimating telescope in the measurement of angles. The measurement of angles by means of the autocollimator resolves itself into the measurement of the distance between two images produced in the focal plane of a micrometer eyepiece. In most cases the light forming these images passes through portions of the object glass on opposite sides of a diameter. It is shown that, when this diameter is perpendicular to the direction of the displacement to be measured, uncertainty and error are introduced on account of any residual spherical aberration of the object glass and the depth of focus of the telescope. One or two particular cases are discussed in which it is shown how this may be obviated.—E. **Hatschek**: The viscosity of colloidal solutions. The author, in reply to some remarks made by Mr. W. B. Hardy in the course of his Guthrie lecture, points out (*a*) that no viscosity formula can cover the stage of gel formation, since the change from a liquid with only slight anomalies to a system having many properties of an elastic solid necessarily precludes this, and (*b*) that the formula given by Einstein, and, independently by himself, for the viscosity of a suspension of rigid spherical particles, does not in any event apply to systems such as discussed by Mr. Hardy, which belong to the class known as emulsoids.

Linnean Society, June 1.—Sir David Prain, president, in the chair.—C. **Reid** and J. **Groves**: New types of fossil Characeæ from the Purbeck Beds. The earliest known remains of undoubted Characeæ were detached fruits recorded from the Lias and Oolite, the earliest remains of the vegetative parts being those in the Middle Purbeck Beds. By subjecting slices of the limestone, in which the plants were found, to a prolonged drip of very slightly acidulated water, so that the Chara-remains were etched out, the authors had been able to elicit much fresh information as to structure, which had not been obtainable from the sections and polished surfaces of chert —Prof. G. E. **Nicholls**: The structure of the vertebral column in the *Anura phaneroglossa* and its importance as a basis of classification.—Prof. J. **MacLeod**: Quantitative variation in certain diagnostic characters of ten species of the genus Mnium. Is it possible to describe and to identify an animal or a vegetable species by means of numbers representing the value of the specific characters? The author has tried to realise this by measuring thirty-eight characters in about ninety species and twenty varieties of the genus Carabus. The war prevented him from finishing and publishing his work. He tried to carry out similar work with plants, taking mosses of the genus Mnium. He limited himself to the study of the leaves of the fertile stem of ten species of that genus. When the length of the successive leaves from the base to the summit of a fertile stem of a Mnium is measured it is seen that the length increases up to a maximum and then diminishes. This curve represents the variation of the character under consideration along the axis. This peculiar form of variation may be called gradation. The gradation of the measured characters of the ten species of Mnium shows much diversity. In these examples it is possible to find the name by four characters; but it may be necessary to use five or more characters. As a dozen characters are available, it is hoped that the identification of a given specimen will be always possible, even if the species were more numerous.—W. L. **Distant**: The Rhyncota from the Indian Ocean.

Dublin.

Royal Irish Academy, May 22.—The Most Rev. Dr. Bernard, Archbishop of Dublin, president, in the chair. —J. **Algar**: Diketones derived from diacetoresorcinoldimethylether. The diketone dianisoylacetoresorcinoldimethylether is obtained by the condensation of diacetoresorcinoldimethylether with anisic ester by means of sodium. Similar diketones may be obtained by the condensation of the dimethylether with the esters of phenylacetic, acetic, and oxalic acids. Diacetylacetoresorcinoldimethylether and di-α-phenylacetylacetoresorcinoldimethylether are colourless crystalline substances, while dianisoylacetoresorcinoldimethylether is coloured slightly yellow, and dimethoxy*iso*phthaloyldipyruvic, ethylester is coloured strongly yellow. These diketones on heating with concentrated hydriodic acid should give dichromone or diflavone derivatives. In the condensations with anisic and phenylacetic esters the yields of the diketones were insufficient to try this reaction. Diacetylacetoresorcinoldimethylether on heating with hydriodic acid gave a tarry product, from which an extremely small amount of colourless substance was isolated, which dissolved in concentrated sulphuric acid, giving a solution with the strong green fluorescence characteristic of chromone derivaties. This colourless substance was probably a dichromone derivative.

Paris.

Academy of Sciences, May 29.—M. Camille Jordan in the chair.—The President gave an account of the scientific work of the late General J. S. Gallieni, correspondant in the section of geography and navigation.—G. **Bigourdan**: Joseph Gaultier and the discovery of the visibility of the stars in full daylight. This discovery has been in turn attributed to Picard (1668), Morin (1635), Hortensius (1633), Schickhardt (1632). It is shown that this discovery was made in 1611 by Joseph Gaultier, of Aix-en-Provence (see p. 328).—P. **Duhem**: The general theory of electric oscillations.—M. **Balland**: An unpublished letter of Parmentier. The letter is dated August 13, 1800, and has reference to the quality of the bread supplied to the Hôtel des Invalides.—B. **Globa-Mikhailenco**: The movement of a billiard ball with sliding and rolling friction.—M. **Mesnager**: All points of a supported thin rectangular plate are lowered on the application of a uniform load, no element remains horizontal, the lines of greatest fall all end at the centre.—C. **Störmer**: The integration of a system of differential equations met with in the study of a cosmical problem. The equations occur in the problem of finding the motion of an electrified corpuscle in the field of an elementary magnet, supposing the corpuscle to be also submitted to the action of a central force emanating from the magnet and inversely proportional to the square of the distance.—Ed. **Sarasin** and Th. **Tommasina**: The proof of a third Volta effect and the experimental confirmation of the given explanation.—F. **Zambonini**: The relations which exist between the angles of mixed crystals and those of their components. The mixed crystals studied included the molybdates of lead and cerium, calcium and cerium, strontium and cerium, lead and didymium, calcium and didymium, calcium-yttrium-cerium, and the tungstates of calcium and cerium. In nearly all the cases studied there was no precise relation between the values of the angles and the composition.—P. **Fallot**: The presence of the Aptian in the sierra of Majorca.—C. **Sauvageau**: The heterogamic sexuality of *Alaria esculenta*.—J. **Amar**: The functional value of the mutilated limbs.—Ch. J. **Gravier**: The Actinean fauna of the island of San Thomé (Gulf of Guinea).—A. **Trillat** and M. **Fouassier**: Study of some factors exercising an influence on the rapidity of evolution of the typhoid bacillus in milk.

Cape Town.

Royal Society of South Africa, April 19.—Dr. L. Péringuey, president, in the chair.—Sir T. **Muir**: Note on pfaffians connected with the difference-product. In addition to the discovery of the connection referred to in the title, there is established a series of theorems bringing pfaffians into relation with permanents and other integral functions.—Sir T. **Muir**: Note on the so-called Vahlen relations between the minors of a matrix. The paper contains a critical examination of the relations in question, and an attempt to put the subject on a sounder basis. There is also incidentally involved a rectification of the statements hitherto accepted regarding the history of the subject.—R. T. A. **Innes**: The development of the perturbative function in the theory of planetary motion. The author has published a paper in the society's Transactions, 1911, upon the Newcomb operators used in the algebraical development of the elliptic perturbative function. The present paper deals with a further extension of the uses of these Newcomb operators.—P. A. **Wagner**: A contribution to our knowledge of the "national game" of Africa. Among most of the native races of Africa there is played in one form or another, either in rows of holes scooped out of the ground or on wood, stone, or even ivory boards, a peculiar game of skill, that from its wide distribution over the continent has been appropriately styled "the national game of Africa." The game is described by the author, and is essentially a war game. Two players or sides direct a contest between armies of equal strength, the object in view being the capture or "killing" of "men" who are represented by small stones, seeds, shells, or fragments of dry cow-dung.—J. **Hewitt**: A survey of the Scorpion fauna of South Africa. The main features of the Scorpion fauna of South Africa have been known for some years, though up to the present time no complete lists or descriptions of the fauna as a whole have been available. In this paper an attempt has been made to provide a trustworthy synopsis of the main distinguishing characters of all the species and varieties known to inhabit South Africa.—S. **Schönland**: Note on a petiole and portion of the lamina of *Cotyledon orbiculata* functioning as a stem. The author describes a case of the formation of adventitious roots on a leaf of *Cotyledon orbiculata*, which remained attached to its stem for seven months afterwards. The roots grew considerably, the petiole and the lower part of the leaf thickening and resembling the stem in outward appearance. So far as examined, the petiole retained the external structure characteristic of such an organ, and did not turn into a stem as was expected, although it had to perform stem-functions for such a long time. In analogous cases in other plants radical changes have been observed.

BOOKS RECEIVED.

Harper's Hydraulic Tables for the Flow of Water, in Circular Pipes under Pressure, Timber Flumes, Open Channels, and Egg-shaped Conduits, with much Accessory Information. By J. H. Harper. Pp. 192. (London: Constable and Co., Ltd.) 8*s*. 6*d*. net.

The Principles of Apprentice Training, with Special Reference to the Engineering Industry. By A. P. M. Fleming and J. P. Pearce. Pp. xiii+202. (London: Longmans and Co.) 3*s*. 6*d*. net.

Chemistry in the Service of Man. By Prof. A. Findlay. Pp. xiv+255. (London: Longmans and Co.) 5*s*. net.

Revista de la Academia de Ciencias Exactas. Fisico-Quimicas y Naturales de Zaragoza. Tomo i. Numero i. Pp. 72; Academia de Ciencias Exactas. Fisico-Quimicas y Naturales de Zaragoza. Discurso leido por su presidente, Dr. Z. G. de Galdeano, en la sesion inaugural celebrada el dia 28 de Mayo de 1916. Pp. 32. (Zaragoza: G. Casanal Coso.)

Coal-Tar and Ammonia. By Prof. G. Lunge. Fifth and enlarged edition. Part i., Coal-Tar. Pp. xxix+527. Part ii., Coal-Tar. Pp. xi+531 to 1037. Part iii., Ammonia. Pp. xvi+1041 to 1658. (London: Gurney and Jackson.) The three parts, 3*l*. 3*s*. net.

Wisconsin Geological and Natural History Survey. Bulletin No. xxxvi. Education Series. No. 4: The Physical Geography of Wisconsin. By Dr. L. Martin. Pp. xxii+549. (Madison, Wis.)

The Science of Musical Sounds. By Prof. D. C. Miller. Pp. viii+286. (New York: The Macmillan Co.; London: Macmillan and Co., Ltd.) 10*s*. 6*d*. net.

Anthropological Report on Sierra Leone. By N. W. Thomas. Part i. Law and Custom of the Timne and other Tribes. Pp. 196. Part ii. Timne-English Dictionary. Pp. 139. Part iii. Timne Grammar and Stories. Pp. xxx+86. (London: Harrison and Sons.)

Specimens of Languages from Sierra Leone. By N. W. Thomas. Pp. 62. (London: Harrison and Sons.)

DIARY OF SOCIETIES.

MONDAY, JUNE 19.

ROYAL GEOGRAPHICAL SOCIETY, at 8.30.—The Gold Coast: Some Considerations of its Structure, People, and Natural History: A. E. Kitson.

TUESDAY, JUNE 20.

ROYAL STATISTICAL SOCIETY, at 5.15.—Annual General Meeting.

MINERALOGICAL SOCIETY, at 5.30.—The Relations of Equivalent Twinning Operations: Dr. J. W. Evans.—(1) The Meteorites of Khairpur and Soko-Banja; (2) The Classification of Meteorites: Dr. G. T. Prior.—Note on a New Occurrence of Gold from Cornwall: Lieut. A. Russell.—Volcanic Rocks from Angola: A. Holmes (with analyses by Dr. H. F. Harwood).—A New Zinc Phosphate from British Columbia: Prof. T. L. Walker.

WEDNESDAY, JUNE 21.

ROYAL METEOROLOGICAL SOCIETY, at 4.30.—Report on the Phenological Observations for 1915: J. E. Clark and H. B. Adames.—Audibility of the Gun Firing in Flanders over the South-east of England, September, 1914—April, 1916: Miller Christy and W. Marriott.—The Relation between Atmospheric Pressure and Rainfall at a Single Station: Lieut. E. H. Chapman.

THURSDAY, JUNE 22.

ROYAL SOCIETY, at 4.30.—Croonian Lecture: Evolution and Symmetry in the Order of the Sea-pens: Prof. S. J. Hickson.

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