THURSDAY, DECEMBER 20, 1917.

THE TUBERCULOSIS PROBLEM.

The Causes of Tuberculosis, together with Some Account of the Prevalence and Distribution of the Disease. By Dr. Louis Cobbett. (Cambridge Public Health Series.) Pp. xvi+707. (Cambridge: At the University Press, 1917.) Price 21*s.* net.

THE physician, the teacher, the administrator, or the member of the Public Health and Hygiene Committee, though he has had at his disposal innumerable text-books, papers, pamphlets, reports of Commissions, Blue Books, and the like, has up to the present had access to no well-digested account of the cause, course, and prevention of tuberculosis, a subject of vital importance to the community.

In writing a logical and well-balanced account of the observations and opinions of others, vitalised by an interweaving of the results of his own wide reading and personal investigation, Dr. Cobbett has done much to fill this gap.

After serving as one of the scientific investigators to the Royal Commission on Tuberculosis, Dr. Cobbett evidently extended his experience of the pathology of tubercular phthisis in a large industrial centre, Sheffield, where this occupational disease is one of the main factors in the morbidity and mortality bill of the town. He had thus an almost unique training, of which we now reap the fruits. His experience of experimental work and its pitfalls, and his acquaintance with the difficulties that face the practical sanitarian and those who are engaged in the treatment of tuberculous patients, enable him to bring to bear a keen critical faculty on the experience and experiments of other investigators, with the result that the work now before us may be looked upon as a "classic," and one that for years to come will, probably, remain the reference-book for those interested in tuberculosis.

The first three chapters, dealing with the incidence, the mean annual mortality, and the decline in mortality from tuberculosis, have already been dealt with by Dr. Cobbett in a series of lectures. For the public health authority and the slum reformer this section—forty-five pages only—will be invaluable.

After brief notes on the etiology of tuberculosis and on the discovery of the tubercle bacillus, the investigations of the Royal Commission on Tuberculosis, of Weber and his colleagues at the Kaiserliche Gesundheitsamt in Germany, of the Bureau of Animal Industry in the United States, and of French, Belgian, and Dutch workers is subjected to critical examination and most impartial summarisation. The evidence of infection and of the importance of "massive" infection in the production of disease, the mass varying with different species of animals and the type—human, *i.e.* naturalised in the human subject; bovine, naturalised in the bovine animal; and avian, the form of bacillus naturalised in, and specially infective for, birds—are in turn dealt with, first in relation to tuberculosis as it occurs in various animals, and then in relation to the production and spread of the disease from these animals to man. After a discussion of the portals of entrance of the infective material, one of the most closely reasoned sections of the book, interesting observations as to the infectivity of the different types of tubercle bacilli on the various animals, (*a*) naturally, (*b*) as the result of experiment, are recorded. From these it is evident that many animals which, owing to their conditions of life, appear to be exempt from "spontaneous" tuberculosis are comparatively easily infected "experimentally." Spontaneous tuberculous infection of the guinea-pig is so rare as to be almost non-existent, but to infection by bacilli of both human and bovine type it is extremely susceptible; whilst the cat, which appears to be specially susceptible to infection by the "bovine" tubercle bacillus, appears to be far more refractory to the "human type" of bacillus.

As the result of the combined experience of the workers dealt with in this book, it is laid down that the tubercle bacillus of bovine type is present in, and the cause of, the lesions of the ox, pig, goat, sheep, horse, camel, cat, dog, monkey, and man, in whom, in addition to the ordinary type of bovine bacillus, a modified form is found in cases of lupus. The avian type of bacillus, found especially in domesticated birds, has also been demonstrated in the rabbit and pig, and in rats and mice coming in contact with these birds. That it plays little, and certainly no important, part in the production of human tuberculosis is generally accepted. The "human type" of tubercle bacillus, in addition to occurring in man, where it is found in the lung and in a modified form in cases of lupus, occurs in the dog, giving rise to about half the cases of tuberculosis in that animal, and in the localised glandular tuberculosis of the pig. It has also been found in captive monkeys, in caged parrots, and in certain mammals—antelope, elephant, and lion—kept in captivity.

Dr. Cobbett, in his earlier chapters, maintains that the human type of tubercle bacillus is responsible for 94 per cent. of the fatal, mainly pulmonary, cases of tuberculosis in man, the remaining 6 per cent. being caused by the bovine bacillus. (In an appendix, as the result of the consideration of more recent investigation on tuberculosis of bones and glands, there is evidence of modification of this opinion.) Of the non-fatal cases of tuberculosis, however, the bovine bacillus is responsible for a much larger proportion—about 50 per cent. Infection with the bovine bacillus is commonest in infancy, uncommon after five years of age, and rare in adult life. It is associated specially with tuberculosis of the alimentary tract and the associated glands, but bovine bacilli have undoubtedly been isolated from a number of cases of pulmonary tuberculosis. In Scotland, and especially in Edinburgh, the bovine bacillus appears to play a more important

part than it does elsewhere in Great Britain or abroad, and the differences of opinion that from the first existed between Koch and those Scottish investigators whose material was obtained in Edinburgh are thus, in all probability, accounted for. This is a matter of great importance and continues to receive attention.

Dr. Cobbett, in summing up, contends that the "bovine bacillus" is less virulent than the "human bacillus" for man, man in this respect differing from all other animals, "for, with the exception of the apes and monkeys, which are equally susceptible, and the dog, which is equally resistant to either type, all other species, so far as is known, are more severely affected with the bovine than with the human bacillus."

Finally, Dr. Cobbett concludes (1) that the importance of tuberculosis is not to be measured only by the deaths caused—above 50,000 per annum in England and Wales alone, mostly "in the prime of life or only a little earlier"—but that, "in addition to these deaths, tuberculosis produces a great number of cripples"; (2) that during the last fifty years "the number of deaths caused each year by tuberculosis has diminished steadily and substantially, and the ratio of deaths to population has fallen by more than 50 per cent.," that it is still declining rapidly "and at an ever-increasing velocity."

In a series of appendices a number of interesting details concerning recent investigations are given. Of these one of the most important is the persistence of tubercle bacilli of human type in the tubules of the cow's udder once it has made its way, and gained a footing, there. This, with an account of the general dissemination of tubercle bacilli after subcutaneous injection, indicates the danger involved in the attempt to immunise milch cows against tuberculosis with living tubercle bacilli. A brief account of the later studies of the types of tubercle bacilli found in the lesions of bone and joint tuberculosis, by which Dr. Cobbett has been led to the conclusion that the percentage of bovine infections is considerably greater than set out earlier in the book, the percentage of bovine infections in England being 14·7 and in Scotland 29·6, is of considerable interest in that here we have a key to the value of the work before us—the extreme impartiality and open-mindedness of the author.

All who are interested in tuberculosis will be well repaid by a careful study—not merely a perusal—of this interesting work, a study rendered far easier by the numerous excellent photographs illustrating points to which the author wishes to direct special attention.

MATHEMATICAL PUZZLES.

Amusements in Mathematics. By H. E. Dudeney. Pp. viii+258. (London: T. Nelson and Sons, Ltd.) Price 3*s.* 6*d.* net.

MR. DUDENEY is famous as a composer of puzzles of a semi-mathematical character, and for some years questions by him of this kind have appeared regularly in several English periodicals. He has now collected a large number of them, added a few new ones, and published the whole in book-form classified under various heads. The questions, more than four hundred in number, range over so wide a field that it is difficult to describe them succinctly, but usually they consist of brief statements, put in a picturesque form, of problems that might conceivably occur. Of these conundrums, some are variations of familiar puzzles, others are new, some are easy, others difficult, but, broadly speaking, all are interesting, and none can be answered without care and thought. In a few cases the point of the problem depends on the wording—a device open to criticism, though one which, in his preface, Mr. Dudeney explicitly defends. The solutions are given separately in the latter part of the book, and no one acquainted with Mr. Dudeney's reputation will need the assurance that they are ingenious and suggestive.

The author—wisely for his purpose—generally avoids lengthy discussions, but the permanent value of the work would have been increased had references to authorities who had treated questions analogous to those submitted been given more freely. For instance, the problem of arranging the twelve members of a bridge club for eleven days so that no two members play together as partners more than once and each member meets every other member as opponent twice is propounded, and Mr. Dudeney gives the bare answer; but there is no reference to Moore's paper of 1896 where the question for $4m$ players is discussed and the theory set out. Again, one "compass" construction is proposed, and the solution of the particular question is given; but a reference to Mascheroni's work of 1795 would have shown that there is a theory of the subject and put the reader on the track of scores of similar problems.

Interspersed in the text are some scholia on problems of particular types, with notes of methods for attacking them. These seem to us the most valuable part of the book, for collections of miscellaneous questions, once read, are not often looked at again; but comments on methods of solution and the past history of problems are of permanent interest. We should have liked to see further discussions of this kind, but with such a feast spread before us it would be ungracious to complain that more has not been given. In one of these scholia there are diagrams of some European labyrinths: Mr. Dudeney says he does not know of any instance of such a figure in an English church, so it may be pointed out that there is one, outlined in marble, on the floor of Ely Cathedral—probably it had not been laid down in 1858, when Trollope wrote his standard account of the subject. In the notes on magic squares there is mention of a transerial or doubly magic square of the eighth order, and it might well have been added that similar squares of higher orders are also known: the formation of such squares is, however, a difficult problem and not to be recommended to non-mathematical readers. In another scholium the digital treatment of

certain number-problems is discussed; we gather that this application is original on Mr. Dudeney's part. Digital properties are but little known to mathematicians, and we hope his example may serve to direct attention to the method: it was freely used by Bidder, the calculating prodigy, and in a certain class of arithmetical problems is of great assistance.

This notice will indicate generally the lines on which the book is written, and on the whole we should say that it is the best miscellaneous collection of the kind with which we are acquainted. The book is profusely illustrated, a marvel of condensation and cheapness, and singularly free from ambiguities and slips. It would be difficult to find a more attractive present for a schoolboy who is interested (as most schoolboys are) in such problems, for wherever he opens it he will find some amusing puzzle which will tax, and in many cases overtax, his ingenuity.

FOSSIL BOTANY.

Fossil Plants: a Text-book for Students of Botany and Geology. Vol. iii., *Pteridospermeae, Cycadofilices, Cordaitales, Cycadophyta.* By Prof. A. C. Seward. Pp. xviii+656. (Cambridge: At the University Press, 1917.) Price 18*s.* net.

IN the present instalment of Prof. Seward's well-known text-book on fossil plants the interest of the subject may rightly be said to culminate. For this volume deals exclusively with the groups of fossil gymnospermous plants, and here between its covers the reader will find spread out for the first time in full and proper perspective the significant discoveries and results of the last fifteen years. The fossil Gymnosperms include the great central groups of seed-plants, and of these one-third of the book is devoted to a consideration of the Pteridosperms and their attendant Cycadofilices, another to the Cycadophyta, whilst the rest is divided between the Cordaiteæ and a long chapter on fossil seeds. This last feature is a most useful digest of a complicated mass of literature, and is a service that will be generally appreciated.

Modern advance, particularly as to the status of the Pteridosperms and the Bennettitales (Cycadophyta), has depended primarily on the study of petrifactions derived from Britain, France, and North America, whilst the knowledge thus obtained has been reinforced and extended by a critical consideration of impressions from which is gained a sort of twilight picture of these ancient vegetations. Prof. Seward possesses the indispensable qualification in the writer of a book like the present of a practical familiarity in handling both these sources of information—petrifactions and impressions—and when, in addition, the task is performed with such evident sobriety and good judgment, the result is a book of the greatest permanent value. It should be added that never before has the subject-matter of fossil botany received such full and connected treatment, nor could the marshalling of the facts be bettered.

In the treatment of his subject-matter the author, in large degree, lets the facts tell their own story. Whilst the theories of fossil botanists are adequately displayed, the author resists all temptations to speculate in the field of plant phylogeny. Nevertheless, apart from his own relevant researches, a good deal of unpublished matter is brought into this book, especially minor points collected from all quarters, each by itself, perhaps, insufficient to justify separate publication, yet in the aggregate appropriately included in a book like this.

Turning over the pages of this book, it is remarkable how large a share in the establishment of fossil botany has been taken by this country. Following the older period of description under Williamson came a newer epoch of critical redescription, with correlations of members previously scattered. With the momentary exhaustion of the English coal-balls of Palæozoic age, the interest passed to the Bennettitales from the American Jurassic rocks, once more to cross the Atlantic to Scotland, where new forms of great antiquity and interest are now coming to light. It is to be expected later on that a more intensive and scientific exploitation of our own and the world's coal resources will continue to produce a harvest of fossil plants rich enough to give full occupation to palæobotanists, and at the same time still further to elucidate the scheme of evolution of the vegetable kingdom.

In conclusion it is fitting to mention that this volume is dedicated by Prof. Seward to the memory of the late Prof. C. R. Zeiller, who for so many years was attached to the Ecole des Mines at Paris. Zeiller appealed to workers in this country not only by reason of his lofty character and eminence as a fossil botanist, but particularly because he, more than any other, established and promoted cordial solidarity between the ranks of fossil botanists on either side of the Channel. It is largely on this account that the recent severe and deplorable losses which the fraternity of palæobotanists has suffered in France (including, in addition to Zeiller himself, Lignier, Grand'Eury, and the elder Bertrand) have evoked in this country a wide and sympathetic response which only the loss of personal friends can arouse.

OUR BOOKSHELF.

With the French Flying Corps. By C. D. Winslow. Pp. 190. (London: Constable and Co., Ltd., 1917.) Price 3*s.* 6*d.* net.

THIS short volume contains the experiences of an American volunteer who joined the French Flying Service, and gives a brief account of the various steps of his training. The book can in no sense be called a scientific work; indeed, the use of technical terms is very loose, as, for instance, the definitions of angle of attack and angle of incidence given on p. 30. Statements such as that on p. 26 to the effect that "when two aeroplanes

are too near each other the suction of their propellers pulls them together, and they become uncontrollable," would certainly not command scientific justification. This technical inaccuracy does not detract from the interest of the book as a record of the actual experiences of an aviator during training and in flying over the enemy's lines. The greater part of the volume consists of such experiences and forms interesting reading. It is well that those who labour in the aeronautical world at home should have some idea of the actual fighting conditions at the Front, and the volume before us gives a very good account of the impressions of a pilot engaged in this thrilling phase of modern warfare. A detailed knowledge of the principles of flight is by no means necessary to enable a man to become an expert pilot, any more than a detailed knowledge of engineering is necessary to enable a man to ride a bicycle or drive a car.

The volume is essentially descriptive and non-technical, but it is, nevertheless, interesting to the scientific worker who wishes to obtain a mental picture of the actual conditions under which our airmen work, and of the wonderful part played by the aeroplane in modern warfare.

The Born Fool. By J. W. Byrd. Pp. 316. (London: Chatto and Windus, 1917.) Price 6*s.* net.

THIS is the record, in considerable detail, of the childhood and adolescence of an engineer and geologist who, born and moving in middle-class circles, convinces himself that it is his duty, on purely altruistic grounds, to marry a woman not only of lower social and intellectual status than himself, but also appreciably older. In parts the story is excellent (if this recalls the curate's egg, *absit omen*), and, despite some few *naïvetés* and trivialities—slight blemishes inseparable, perhaps, from the maiden production of any author—it is a very interesting study, abounding in natural touches and realistic incidents.

The atmosphere of the tale is to a large extent engineering and geological. The hero, at the age of twenty-one or thereabouts, becomes a fellow of the Geological "Institute," in consequence of a thesis of extraordinary merit and a discovery of unique importance. He also acts as resident engineer on water-supply undertakings of some magnitude. Precocity of this kind is, of course, not unusual in the realm of fiction. At the same time, the book envisages certain sociological, sexual, and religious problems in a way which will appeal to thoughtful minds, so that there is a wide and varied range of interest for many readers.

Quantitative Chemical Analysis. Adapted for Use in the Laboratories of Colleges and Technical Institutes. By Dr. F. Clowes and J. B. Coleman. Eleventh edition. Pp. xxiv+580. (London: J. and A. Churchill, 1918.) Price 12*s.* 6*d.* net.

THE eleventh edition of this well-known work of reference has been carefully revised and new matter has been introduced in the Appendix. The results of typical analyses obtained in the laboratories of the authors occupy eleven pages, and will prove useful to analysts and others for reference and guidance; the list of important works of reference provided will also be equally serviceable.

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.*]

Ramsay Memorial Fund.

WE are asking the hospitality of your columns to enable us to report the progress of the Ramsay Memorial Fund, which was instituted just a year ago with the object of raising a sum of 100,000*l.* as a suitable memorial to the late Prof. Sir William Ramsay. The fund has now reached a sum of just above 30,000*l.* The latest and most important donation to the fund has been a sum of 5000*l.*, contributed by Mrs. Wharrie. It may be remembered that Messrs. Brunner, Mond and Co. have promised a similar sum of 5000*l.* The honorary treasurers have received a large number of other sums, ranging from 1000*l.* to one guinea. From this it will be seen that the Ramsay Memorial Fund has now passed its experimental stage, and is making good progress towards the sum which the committee aim at raising. The Executive Committee are confident that with the assistance of the large number of co-operating committees which have been formed in all parts of the British Empire and many foreign countries they will be successful in completing the fund of 100,000*l.*, but in order that this may be the case they must appeal to the generosity of the public for further donations, large and small. They hope that the generous example of Mrs. Wharrie and of Messrs. Brunner, Mond and Co. will be followed by others, but they will also greatly welcome gifts of any amount ranging from one guinea upwards.

The fund of 100,000*l.*, when raised, will be devoted to two objects of great national importance: the establishment of Ramsay Memorial fellowships for research in chemical problems as applied to industry, and the foundation of a memorial laboratory of engineering chemistry. Those who contribute to the Ramsay Memorial Fund are contributing in the most definite and direct way to the national prosperity after the war, in which the advancement of science must play an increasingly important part. Donations should be sent to the joint honorary treasurers, Ramsay Memorial Fund, University College, London, Gower Street, W.C.1.

RAYLEIGH,
Chairman of the General Committee.
HUGH BELL,
Chairman of the Executive Committee.
GLENCONNER,
J. N. COLLIE,
Honorary Treasurers.

The Beginnings of Porcelain in China.

IN the review of our publication by Dr. J. W. Mellor (NATURE, October 4, p. 88) there is a misunderstanding which we feel should not be allowed to pass in the interest of your readers. Dr. Mellor states that we regard the so-called Han pottery as porcelanous, and as the forerunner of true porcelain. Such a statement has never been made; we always held, and still hold, that Han pottery is nothing but a common stoneware.

The pottery newly discovered in Shensi, and forming the subject of our investigation, is a distinct group, which, as maintained repeatedly, was not turned out under the Han, but long afterwards, at the end of the third century A.D. In its form and design it is a direct descendant of Han pottery, but its glaze, as proved by analysis, is porcelanous. For this reason it has been styled "Han porcelanous pottery."

Dr. Mellor mentions only the analysis of the green-glazed Han pottery, which has no connection whatever with the porcelanous material analysed. The body of this Han fragment is a coarse red earthenware, which can in no sense be considered porcelanous. Certainly the porcelanous body analysed does not appear porcelanous to casual inspection. The true character of the ware appears only when a slide is prepared and examined under a petrographic microscope, when the porcelanous character becomes so strongly evident that mistake is impossible. The frothiness of the body which masks its porcelanous features from macroscopic observation is also plainly visible in the slide.

We are not at all interested in the philological interpretations of the Chinese term *ts'e*. Our identification of this new pottery with the early *ts'e* of Chinese records rests solely on archæological arguments, not on any philological considerations.

B. LAUFER.
H. W. NICHOLS.

Field Museum, Chicago, November 8.

I AGREE with most of what I have read in Messrs. Laufer and Nichols's work which made any impression on my mind, and I also agree likewise with what is said in the above letter. I except the impression conveyed by the title, and in some parts of the text of the excellent brochure, as well as in the present letter, namely, that the Han pottery (body and glaze) referred to can be called porcelanous or the froth of porcelain. As they say, it is stoneware—and is not a particularly good variety at that. If Messrs. Laufer and Nichols will apply the petrological test to a good class of "acid brick," such as is used in the Glover's tower of a sulphuric acid works, they will find just as much, or even more, ground for stating that these bricks are porcelainic. I have compared the two bodies and would vote in favour of the bricks. Similar remarks would also apply to ancient and modern ware made from the so-called vitreous clays when fired, for they, too, have a similar character, and many have a similar chemical composition. Ware like the so-called Böttcher, or Böttger, "porcelain" should not be called porcelainic—excepting, perhaps, as a "registered trade mark" or in metaphor. Nor is it any real contribution to history to call it the precursor of porcelain in Europe when we recall that numerous analogous cases must have been in the alchemist's hands centuries before Böttger's time. The analogy is surely valid also in China.

In my comments I tried to convey the impression that Messrs. Laufer and Nichols's suggestion was not in accord with the technical concept of porcelain in our country, but I can quite understand that they may be working with another concept of porcelain which enables them to apply the term as an adjective to the pottery in question. It would be better if these points were threshed out before a technical society, since this is scarcely the place to make an attempt to develop a standard definition of porcelain uniformly acceptable. The main discussion would, I take it, work round the body—the glaze *per se* would give less trouble.

Nearly all beginnings are obscure, and Messrs. Laufer and Nichols have made a meritorious contribution to the subject which in the past few months I have strongly recommended to many students.

J. W. MELLOR.

Stoke-on-Trent, December 6.

MAGNETIC AND ELECTRICAL OBSERVATIONS AT SEA.[1]

THE handsome volume before us is principally concerned with the magnetic and electrical observations made at sea by the *Galilee* (1905–8) and the *Carnegie* (1909–16). It also includes some observations made on shore in connection with the cruises of the two vessels. Some of the contents appeal only to a narrow circle, but much is of general interest. Thus we have the "charter party" by which Mr. Matthew Turner, managing owner of the brigantine *Galilee*, of the net tonnage of 328, contracted to maintain the vessel tight, staunch, sound, strong, and seaworthy with a sailing master, two mates, six seamen, and two cooks. Then we have the instructions issued by the director of the Department of Terrestrial Magnetism to the master before each cruise, the report of the master, the daily log, and particulars of all the instruments on board. The parts of most general interest are the descriptions of the observational instruments copiously illustrated in the plates, the reduction formulæ, the tables of observational results, including the graphical illustration on pp. 424–29 of the errors in current magnetic charts, and the discussion of the electrical observations. A certain amount of the material has already appeared in a less complete form in earlier publications, but the present volume collects everything together and shows the gradual development of ideas.

The portions of the volume relating to the *Galilee* and the *Carnegie* magnetic observations are indexed separately, and there is a third index for the electrical observations, so that the volume is practically in three parts. The *Galilee* seems to have been an excellent sailing vessel, and as suitable a one for magnetic observations as could have been hired in 1905. But, like any ordinary vessel, she had a magnetic field of her own, the elimination of which required frequent "swingings" of the ship and all the elaborate procedure which renders magnetic work at sea so burdensome. With the experience they gradually acquired, Dr. Bauer and his coadjutors gradually saw their way to the construction of a ship practically free from iron. Plans were prepared in 1908 by Mr. Gielow, of New York. The keel was laid in February, 1909. In June, 1909, the *Carnegie* was duly launched and christened, and on August 21 of the same year she entered on her trial cruise. With equipment she cost about 115,000 dollars. She is primarily a sailing vessel, but with auxiliary propulsion. The motive power is derived from an internal-combustion engine of 150 horse-power, working with gas produced from anthracite coal. The engine itself is essentially bronze, but steel of a total weight under 600 lb. had to be used for certain parts. The *Carnegie* has been "swung" on various occasions, but, to all intents and pur-

[1] Researches of the Department of Terrestrial Magnetism. Vol. iii., "Ocean Magnetic Observations, 1905–16, and Reports on Special Researches." By L. A. Bauer, Director, with the collaboration of W. J. Peters, J. A. Fleming, J. P. Ault, and W. F. G. Swann. Pp. v+447, with 25 plates and 35 figures in the text. (Washington, D.C.: The Carnegie Institution of Washington, 1917.)

poses, when proper care is exercised in stowing the cargo, she is non-magnetic. This enables observations to be taken in less time and with higher accuracy than on the *Galilee*. Between them the *Galilee* and the *Carnegie* have traversed 224,000 miles of ocean, and declination observations have been taken once for each 109 miles on the average, but, owing to the improved facilities, the average distance apart of the *Carnegie's* stations has been less than half that of the *Galilee's*.

The experience of sea conditions has led to modifications of the instruments available in 1905 and to the development of new ones. Much work has been done with the Lloyd-Creak dip-circle, or,

FIG. 1.—The non-magnetic ship, the *Carnegie*.

as the present volume calls it, the "sea dip-circle." This was devised by Capt. Creak as an improvement of the Fox circle. When provided with deflection needles and weights, after the method devised for land circles by Humphry Lloyd, it supplies the total force as well as the dip (I), and so indirectly the horizontal force (H). By adding a compass needle and a simple contrivance which enables the distance of the deflecting needle to be varied, the Carnegie Institution has made the instrument also give the declination (D), rendering it at the same time more serviceable for its original purpose. While the dip-circle can supply values for D and H, these are not quite so accurate as those given by special D and H instruments. The primary declination instrument as used on the *Carnegie* is a somewhat elaborate modification of the Ritchie liquid compass. For measuring H a new instrument termed a "sea-deflector" has been invented. It employs a deflection method analogous to that adopted with the ordinary land magnetometer. The deflected needle is the magnet system of a liquid compass; the deflecting magnet is horizontal, but with its centre in the same vertical as the centre of the deflected needle. It is attached to a sighting arrangement. When the compass needle is sighted it is known that it and the deflecting magnet are at right angles to one another. If when this occurs u is the inclination of the compass needle to the magnetic meridian,

$$H = mC/\sin u,$$

where C may be regarded as a constant, and m is the magnetic moment of the deflecting magnet. Allowance may be made for the variation of m with temperature; and comparisons made, when opportunity offers, with ordinary magnetometers on land supply the necessary information as to the decay of m with time. Another new departure, known as the "marine earth-inductor," is a form of dip-inductor suitable for use at sea. It has a moving-coil galvanometer, the sensibility of which with a scale distance of 1 metre is 1 mm. $= 10^{-8}$ ampere, the period being 2·4 seconds. An absolutely null method is not feasible, but this does not prove a serious drawback when care is taken to secure a nearly uniform speed of rotation of the coil. Under favourable conditions the inductor appears an instrument of higher precision than the dip-circle, but it requires at least two, and preferably four, observers. A guiding principle seems to have been to have at least two independent ways of measuring D, I, and H, and to use the less exact instrument as a check on the more exact.

The magnetic sea observations taken on each cruise are numbered and tabulated separately. Each table gives the date, the geographical co-ordinates, and the values of D, H, and I. Except in the case of the two last cruises of the *Carnegie*, the results for which appear only to be preliminary, the tables also include particulars of the hours of observation, the instruments used, the ship's course, the angle of roll, the state of the sea and the weather. Observations were often taken with

the ship rolling through 30°, and even at times 40° or more.

The magnetic observations made on shore are discussed in separate tables, and there are exact descriptions of the stations occupied. Considerable local disturbance was encountered in Madeira, the Bermudas, St. Helena, Mauritius, and especially in Iceland near Reykjavik. In such cases several adjacent sites were occupied.

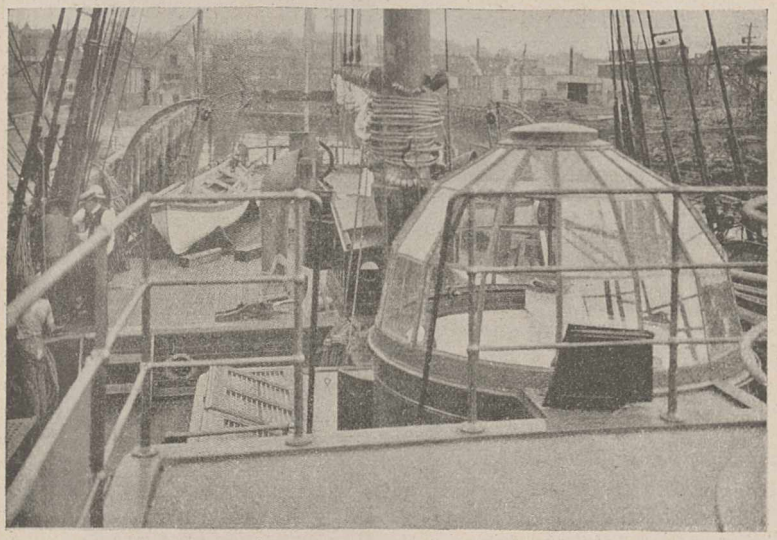

FIG. 2.—After observing-dome on the *Carnegie* with sea-deflector inside.

The part dealing with atmospheric electricity possesses many features of interest. Several new instruments are described, one for measuring potential gradient at sea. This was standardised by means of simultaneous observations on shore when the *Carnegie* was in harbour. The electrical elements observed included the potential gradient, the conductivities arising from positive and negative ions, the number and mobility of positive and negative ions, the air-earth current, the number of pairs of ions produced per c.c. per second in a closed copper vessel, and the radio-active contents of the air and of sea-water. Regular meteorological observations are also included. The results obtained are numerous and are given in tables on pp. 403–5. The discussion of the results is accompanied by much information as to the corresponding data obtained by previous observers on land and sea, and is practically equivalent to a text-book on atmospheric electricity.

The conclusions drawn are summarised on p. 422, the following being perhaps the most interesting. The potential gradient seems to be much the same over the different oceans, the mean daily value being about 113 volts per metre. There is a distinct diurnal variation, of the same general type as that for the year as a whole at Kew, *i.e.* having two maxima and two minima, but the principal maximum occurs near midnight, *i.e.* two or three hours later than at Kew. The average numbers of *plus* and *minus* ions per c.c. were respectively 804 and 677, numbers very similar to those encountered on land. The mean value found for the mobility was 1·30 cm./sec. for both *plus* and *minus* ions. The mean value found for the air-earth current was $9{\cdot}5 \times 10^{-7}$ E.S.U. The number of pairs of ions produced per c.c. per second in a closed copper vessel shows little variation over the ocean whether with locality, season of the year, or hour of the day. The mean found was 3·8. The average radium emanation contents in curies per cubic metre of air found over the Pacific and sub-Antarctic oceans were respectively $3{\cdot}3 \times 10^{-12}$ and $0{\cdot}4 \times 10^{-12}$, the larger of these values being only some 4 per cent. of the average value over land.

We learn that two more volumes, iv. and v. of the series, are to deal with later observational results, secular change, and the reduction of all the results, both for land and sea, to a common epoch. It is hoped that complete world charts based on these observations may be constructed during 1918.

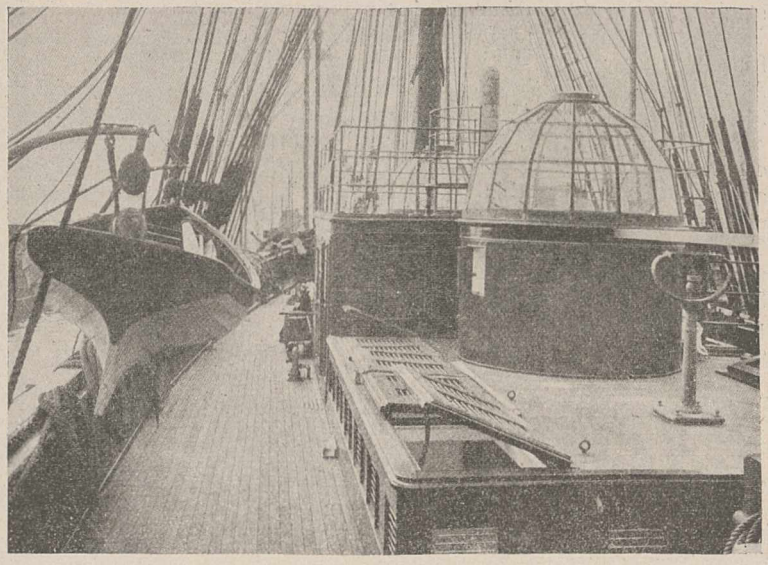

FIG. 3.—View of the bridge on the *Carnegie* and observing-domes.

C. CHREE.

AGRICULTURAL EDUCATION AND RESEARCH IN THE UNITED STATES.

IN the latest bulletin of the Carnegie Foundation for the Advancement of Teaching[1] an elaborate account is presented of the course of legislation in America which led to the foundation and endowment of the agricultural colleges and experiment stations. The former are known as the "land-grant" colleges, and this publication explains how this name arose. The foundation of these colleges, of which each of the States in America possesses at least one, dates from 1862, when the Morrill Act of that year appropriated the proceeds of six and one-third million acres of public lands for the purpose of founding in each State of the Union a College of "Agriculture and the Mechanic Arts." For many years after their foundation the land-grant colleges did not confine themselves to agriculture, and up to the close of the nineteenth century the number of students who graduated in agriculture was comparatively small.

In 1890 further endowments were voted by Congress, which by annual increments finally reached 50000*l.* per annum for each State in the Union. Again, in 1907, the annual subvention to each State was raised to 10,000*l.* per annum. In the meantime a step of great consequence was taken, one which has done much to stimulate agricultural education and research in the United States. This was the establishment of experiment stations in connection with the land-grant colleges as a result of the famous Hatch Act of 1887, which appropriated 3000*l.* per annum for each of these stations. By 1906, when an Act was passed raising the appropriation for each station to 6000*l.*, forty-eight of these stations had been established. Again, in 1914, further appropriations were voted for college "extension" work, beginning with 2000*l.* for each State, to be followed by annual increments of indefinite amount until the aggregate appropriations for this purpose in the whole country should reach a sum of 800,000*l.* But still Congress was not satisfied. By an Act passed this year further appropriations were sanctioned for the furtherance of agricultural education, which by 1926 will amount to 600,000*l.* per annum. Excluding the appropriations in aid of extension work, the aggregate Federal grants in aid of higher agricultural education and research are now 1,175,000*l.* per annum. The individual States of the Union have also increased their aid *pari passu*, so that in 1915 the total income of the colleges and experiment stations had reached the astonishing figure of 7,200,000*l.* The expenditure on higher agricultural education and research in England and Wales has a sorry appearance if contrasted with these remarkable figures. The normal State expenditure per annum in England and Wales is about 20,000*l.* for higher education and 35,000*l.* for research, not much more than what one State in America receives for similar purposes.

The author of the bulletin under notice expresses some alarm at the rapidity of recent developments. He appears to think that there is still too much fluidity of opinion in regard to the scope and methods of vocational education, and that the money available will be squandered on unfruitful educational experiments. However that may be, it is surely a healthy sign that public opinion, as reflected by the Legislature, recognises the need for better scientific and technical training.

It is somewhat remarkable to find that attention has been given to military training in the land-grant colleges ever since their foundation. Special officers are detailed to take charge of the instruction in military subjects.

A remarkable feature of the development of agricultural education in America is the sudden leap upwards which the number of students of agriculture has taken since 1906. In that year the total number of students was nearly 3000; in 1914 the figure was nearly 15,000. The bulletin fails to give any satisfactory reason for the suddenness with which the change set in. We venture to suggest that the demand for higher education in agriculture may have been stimulated by the extensive programme of demonstration fields upon which many of the States have recently embarked. These demonstration fields are designed to provide object-lessons of improved practice, and the extent to which they have been scattered over the country far surpasses anything that has ever been attempted here.

What is the lesson for this country from this record of American experience and progress? Surely, that we, too, should have faith and the courage to spend, especially on research. To begin with, some of the expenditure might be unfruitful, but one of the main obstacles to progress in the past has been the failure of agricultural research to attract the best scientific talent, a failure in large part due to the fact that the study of the sciences bearing on agriculture offered no career. Even as matters stand, the salaries of the teaching and research posts are inadequate, and in view of the rising demand for scientific work in the industries generally, the inadequacy is becoming more acute.

[1] Bulletin No. 10, "Federal Aid for Vocational Education." By Dr. I. L. Kandel. (New York City: Carnegie Foundation for the Advancement of Teaching.)

DR. A. M. W. DOWNING, F.R.S.

DR. ARTHUR MATTHEW WELD DOWNING, whose death was announced in NATURE of December 13, was born in Ireland on April 13, 1850, being the youngest son of the late Mr. A. M. Downing. He graduated at Trinity College, Dublin, where he gained the gold medal of his year in mathematics. He went soon afterwards to the Royal Observatory, Greenwich, where he was an assistant for twenty years. He was elected a fellow of the Royal Astronomical Society in 1875, and of the Royal Society in 1896.

He was secretary of the former society from 1889 to 1892, and afterwards vice-president. He contributed seventy-five papers to it between 1877 and 1910, which show the keen interest that he took in the improvement of the fundamental constants of astronomy. He revised Taylor's Madras Catalogue and made systematic comparisons of the Star Catalogues of Greenwich, the Cape, Washington, Cordoba, Melbourne, Hong-Kong, etc., with the object of deriving their systematic errors. He discussed the measures of the planetary diameters, and investigated the errors of the tabular orbits of Juno and Flora.

This work formed an admirable preparation for the post of superintendent of the Nautical Almanac Office, to which Dr. Downing was appointed in 1892 on the retirement of Dr. Hind. He retained this post for eighteen years, retiring early in 1910. During his tenure of office the solar and planetary tables of Newcomb and Hill replaced those of Le Verrier, the list of ephemeris stars was greatly enlarged, and Besselian coordinates were introduced into the eclipse and occultation sections, facilitating the accurate computation of these phenomena. The "Lunar Distance" tables were dropped, as practically obsolete in navigation, and their place was taken by the physical ephemerides of the sun, moon, and planets, the regular publication of which is a great convenience to observers. They were previously contributed to the Monthly Notices by Mr. Marth, and have led to an increase of our knowledge of the surface currents of Jupiter. Dr. Downing took part in the international conference of directors of ephemerides which met at Paris in 1896 to endeavour to attain uniformity in the adoption of astronomical constants: its efforts were partly successful, agreement being reached on the questions of precession, nutation, aberration, and solar parallax. He was one of the founders of the British Astronomical Association in 1890, and was its second president (1892–94). He took part in two of the eclipse expeditions organised by it—to Vadso, Lapland, in 1896, and to Plasencia, Spain, in 1900.

Dr. Downing availed himself of the publication of the Cape Photographic Durchmusterung in 1899 to investigate the distribution of stars south of the equator, for which complete homogeneous material had previously been lacking. He found that the galactic condensation of the faint stars was greater in the southern hemisphere than in the northern. In conjunction with Dr. Johnstone Stoney he calculated the perturbations of the Leonid meteors between 1866 and 1899. Their results were published too late to warn the public of the probable non-appearance of the shower in 1899, so that considerable disappointment was caused, though the result was really in accord with calculation.

Dr. Downing spent the last few years in quiet retirement, owing to failing health. His tragically sudden death on December 8 resulted from angina pectoris. He leaves a widow and daughter.

A. C. D. CROMMELIN.

NOTES.

THE death of Mrs. Garrett Anderson on December 18, at eighty-one years of age, deprives the world of a pioneer whose persistent efforts opened to women the portals of institutions having the power to confer qualifications to undertake medical practice. She was the first woman to secure a medical diploma in this country, and she lived to see a steady stream of capable women enter the door which she was chiefly the means of opening. Mrs. Garrett Anderson was born in London in 1836, and in 1860 began her medical studies with the view of obtaining an English qualification as a practitioner. No medical school of the metropolis would receive her as a student, and the Royal College of Surgeons, as well as the Royal College of Physicians, declined to allow her to sit for their examinations. She obtained, however, private tuition in anatomy and surgery, and studied at the London Hospital as a nurse; and after completing her course, was able to establish her claim to be examined by the Society of Apothecaries, which was compelled by its charter to admit to examination all persons, irrespective of sex, who presented themselves after passing through an approved course of study. She thus obtained the desired qualification of licentiate of the society, and began to practise medicine. In 1866 she opened a dispensary near Lisson Grove, Marylebone, and out of this undertaking grew the New Hospital for Women in the Euston Road, of which she remained senior physician until 1890. With Miss Jex-Blake, Mrs. Garrett Anderson endeavoured to induce the University of Edinburgh to grant medical degrees to women, but unsuccessfully. She went to France, however, and obtained the degree of doctor of medicine of the University of Paris in 1870. The refusal of the northern University to admit women to its medical schools led to the establishment of the London School of Medicine for Women, and the alliance of this school with the Royal Free Hospital completed the provision for teaching required by the General Medical Council. From its foundation in 1876 until 1898 Mrs. Garrett Anderson lectured to the students on medicine, and from 1883 to 1903 acted as dean of the school. In 1896–97 she was president of the East Anglian branch of the British Medical Association, and gave an address on "The Progress of Medicine in the Victorian Era." At Aldeburgh, Suffolk, which was her home for many years, she was elected mayor in 1908, and was the first woman to occupy such a post in England. In August last the honour of Commander of the Order of the British Empire was bestowed upon her by the King. Medical women will long cherish the memory of the pioneer to whose courage and strong character they largely owe the position now occupied by them.

THE student of natural science is continually surprised by the inaccuracies which appear when writers and artists in the general Press touch even the most elementary conceptions of the natural world in which we live. Mr. J. Reid Moir has just directed our attention to a remarkable case in a large advertisement published in various newspapers on December 4. It purports to be a reply to a question propounded in displayed type, "How did Man conquer the Dinosaurus?" and is made attractive by a sketch of a Diplodocus-like animal being attacked by primeval man. The most elementary acquaintance with geology would have assured the author that his question could never arise, because all the dinosaurs were extinct long before man appeared; and even if, presuming on little knowledge, he had mentally confused a dinosaur with a mammoth, he still made a fundamental mistake (as Mr. Moir points out) in providing the huntsman with a Neolithic implement.

IT has been announced that a sum of money amounting to about 250,000*l.* has been bequeathed by the late Mr. G. F. Melville, advocate, Edinburgh, to be devoted to "the care and cure of cancer"; the benefits of the bequest do not, however, accrue until the death of certain beneficiaries under the will. The trust is to be administered by the Dean of the Faculty of Advocates, the Deputy-Keeper of the Signet, and the Master of the Merchant Company, and it is understood that the trustees have considerable discretionary powers in the choice of the methods by which the object of the testator may be best attained. No doubt the questions of provision, both for research work and for the care of patients, will be considered. In Edinburgh at present the treatment of cancer patients is carried on in the general hospitals, an arrangement which has the obvious advantage of not attaching a stigma to the sufferer from malignant disease, but as the hospital accommodation in the city has not increased with the population an addition to the available resources for treatment would be advantageous. On the research side, though isolated investigations, such as those of Russell on cancer bodies, have been carried out in Edinburgh, no organised attack has been made on the problems of cancer. In the summer of 1914, however, a scheme was being prepared for the erection, under the joint auspices of the University and of the Royal College of Physicians and the Royal College of Surgeons, of an extensive research institute in medicine as a memorial of Lister's connection with the Edinburgh School. This project the war has interfered with, but the promoters are definitely committed to carry it through whenever circumstances permit. It was part of the original plan that special provision should be made for research on cancer, so that the authorities of the Medical School have been quite alive to the necessity for initiating work on the subject.

DR. G. P. GIRDWOOD, emeritus professor of chemistry, McGill University, Montreal, died on October 2, in his eighty-fifth year. We are indebted to the *British Medical Journal* for the following particulars of his career. Dr. Girdwood was the son of Dr. G. F. Girdwood, and was born in London on October 22, 1832; he was educated at a private school, and later at University College and St. George's Hospital. He settled in practice in Montreal in 1864, and in the following year took the degrees of M.D., C.M. at McGill University. In 1869 Dr. Girdwood was appointed lecturer in practical chemistry in the faculty of medicine, McGill University; in 1872 he became professor of practical chemistry, and two years later professor of chemistry. When he retired from this chair in 1902 he was named emeritus professor of chemistry. He occupied a number of other important positions, among them the presidency of the Röntgen Society of America and the vice-presidency of the Canadian Branch of the Society of Chemical Industry. He was also one of the original fellows of the Royal Society of Canada. "Dr. Girdwood will be remembered as a conspicuous figure among the scientific men of Canada during the last quarter of the nineteenth century—an example of the all-round man of science that will become rarer in this age of specialisation; for, though fundamentally a chemist, he had a sound knowledge of medicine, surgery, medical jurisprudence, botany, physics, and microscopical technique, including photomicrography. The Rodgers and Girdwood method of detecting strychnine was devised by Dr. Girdwood and Dr. Rodgers, of London, and it was Dr. Girdwood also who first applied reagents for the detection of forgeries, counterfeits, and the identification of handwriting. He was one of the first to apply the stereoscopic principles to X-ray prints."

WE regret to learn from the *Memorias do Instituto Oswaldo Cruz* (vol. viii., fasc. ii.) of the death of the distinguished director of the institute, Dr. Oswaldo Gonçalves Cruz. After completing his course as a student of medicine in Brazil, Dr. Cruz worked for some time in the Pasteur Institute in Paris. Soon after his return to Brazil the Government decided to take measures for the improvement of the health of Rio de Janeiro, especially in regard to yellow fever, and in 1903 Dr. Cruz was appointed head of the public health department, with full powers to take all necessary measures. He prosecuted the campaign against yellow fever with scientific method and with the utmost vigour, instituting for this purpose "mosquito brigades" and allied services, comprising about 2000 men. The breeding places of *Stegomyia calopus*, the carrier of yellow fever, were abolished or screened, all infected persons were isolated, and in about three years yellow fever was stamped out in Rio. Dr. Cruz also devoted careful attention to measures for the suppression of smallpox and the plague with such success that by 1909 smallpox had almost disappeared in Rio, and there has been no case of plague for five or six years. In 1901 Dr. Cruz was appointed director of an institute for work on serum therapy; he soon enlarged the scope of the work so as to include other branches of experimental medicine, together with pathology and parasitology, and about ten years ago the present institute was built and named in his honour. He was a man of great activity and stimulating personality, and brought together a band of workers who have made his institute famous as a centre of researches of a high order. Dr. Cruz will be held in honoured remembrance for his powerful support of all phases of medical research in Brazil, and for his inestimable services in the cause of public health in Rio.

AT the annual meeting of the Yorkshire Geological Society held at Leeds on December 12, Mr. T. Sheppard read a paper on "Martin Simpson and his Work." Simpson was born in 1800 and died in 1892. He spent most of his life in the Whitby district, and for more than half a century had charge of the valuable geological collections in the Whitby Museum, though for a short period he was the curator of the Yorkshire Geological Society's collection. He was one of the first workers among the Liassic rocks of Yorkshire, and considering the early date of his researches, the enormous amount of information he accumulated is remarkable, and his methods of research had a surprisingly modern air. He was the author of a number of geological memoirs, most of which are now exceedingly scarce. Mr. Sheppard exhibited a complete series of these works, which he had collected, the most important being a memoir on the "Ammonites of the Yorkshire Lias," which was published in 1843, and long ago was said to be so rare that only one copy existed. Another work, published when Simpson was eighty-four years of age, is "The Fossils of the Yorkshire Lias," in which no fewer than 743 species were enumerated and described. Simpson measured with a foot-rule the thickness of the beds in the cliffs north and south of Whitby, taking special note of the specimens peculiar to each bed—a very early example of zonal collecting.

THE next meeting of the Faraday Society will be held on January 14 in the rooms of the Royal Society of Arts at 5.30 p.m., when a general discussion on the setting of cements and plasters will be opened by Dr. C. H. Desch.

WE regret to note that *Engineering* for December 14 records the death on December 9 of Mr. Wm. M. Urie. Mr. Urie was born in 1850, and after a varied engineering career at home and on the Continent, became

works manager of the Caledonian Railway Company's Works at St. Rollox, Glasgow. He was elected a member of the Institution of Mechanical Engineers in 1899.

We learn from the *Chemical Trade Journal* that Mr. W. J. E. Foakes, late Chief Government Inspector of Explosives for Cape Colony, has died in London. For eleven years Mr. Foakes was chief assistant and partner with the late Dr. Dupré, chemical adviser to the Home Office. He was appointed Chief Government Inspector of Explosives for Cape Colony on the recommendation of Sir Vivian Majendie in 1898.

The council of the Institution of Electrical Engineers has passed the following resolution, which has been transmitted to Sir Albert Stanley:—"That the council of the Institution of Electrical Engineers welcomes the Non-ferrous Metals Bill, approves its principles, and congratulates the President of the Board of Trade on its introduction. The council, representing an institution the members of which are interested so widely in the supply of non-ferrous metals, unanimously supports this measure designed to keep the control of the supply of these essential metals in British hands."

The thirty-fifth annual meeting of the American Ornithologists' Union was held in Cambridge, Mass., on November 12–16. The following officers were elected for the ensuing year:—*President*, J. H. Sage; *Vice-Presidents*, H. W. Henshaw and Dr. Witmer Stone; *Secretary*, Dr. T. S. Palmer; and *Treasurer*, Dr. J. Dwight. Two additions were made to the list of honorary fellows, Dr. A. H. Evans and Mr. W. L. Sclater, and Dr. F. E. Beddard was elected a corresponding fellow. The next meeting, in 1918, will be held in New York City.

Many who are acquainted with the works of Mr. Ewing Matheson will regret to hear of his death, which is announced in *Engineering* for December 14. Mr. Matheson was in his seventy-eighth year, and had been a member of the Institution of Civil Engineers since May, 1876. His books deal with civil engineering subjects, and he was a partner in the firm of Messrs. Andrew Handyside and Co., Derby, in which connection he was actively associated in all the large civil engineering undertakings successfully carried out by his firm. He took an active part in the business and municipal life of Leeds.

It is reported in *Science* that a special board of chemists has been appointed in the United States to investigate explosives and the uses of gases in warfare and to act as advisers to the Bureau of Mines. The board will study the problem of increasing the production of materials used in the manufacture of explosives and will advise the bureau in the operation of the recently enacted law regulating the sale of explosives. The members are:—Dr. W. H. Nichols, of the General Chemical Company, New York (chairman); Prof. H. P. Talbot, head of the chemical department of the Massachusetts Institute of Technology; Mr. W. Hoskins, of Chicago, a consulting chemist; Prof. H. P. Venable, of the University of North Carolina; Prof. E. C. Franklin, of Stanford University; and Dr. C. L. Parsons, of the U.S. Bureau of Mines.

The natural history and possibilities of the Murray River are graphically described in the *Victorian Naturalist* for August by Mr. O. W. Rosenhain. A system of irrigation canals and locks, he points out, would convert many thousands of miles, now barren waste, into fertile land. He deplores the destructiveness of the early settlers, who have destroyed millions of pounds' worth of trees, the bleached trunks of which now extend along the banks on either side as far as the eye can reach. A scheme of irrigation has actually been proposed by which immense areas all along the Murray, from Echuca to Lake Alexandria, will be converted into fertile land capable of supporting more than the whole present population of Australia. At a rough estimate, it is contended, more than 3,000,000 acres could be transformed into corn and grass land and flourishing orchards. It is to be hoped, therefore, that this work of reclamation will not be long delayed.

In January, 1914, two young king penguins, still in the nestling-down stage, were presented to the Scottish Zoological Society. A very careful study of their moulting has been made by Prof. J. Cossar Ewart and Miss Dorothy Mackenzie, and they have placed the results of their observations on record in the Transactions of the Royal Society of Edinburgh, vol. lii., part i. (1917). So good an opportunity of studying this stage of the moulting of this species has never fallen to the lot of any previous workers, and the authors have made good use of their chance. Perhaps the most interesting item in this communication is that concerning the arrested moult, which showed signs of beginning in May, when it was four months overdue, and was not resumed until August. It then followed its normal course, but the resultant plumage was scarcely different from that of the adult—that is to say, the immature dress was skipped. A precisely similar omission was induced by changing the conditions of the environment in the case of bobolinks by Mr. W. Beebe in the New York Zoological Gardens about ten years ago. But here the change was from nuptial to nuptial plumage, instead of from the nuptial to the eclipse, or "winter," plumage. The authors, by the way, scarcely seem to have grasped the nature of these plumages, to judge from their comments thereon. Nor is their comparison between the kingfisher and the king penguin likely to be regarded by ornithologists as more happy. We cannot answer for the Neo-Lamarckians, but we find it difficult to believe that such a one "might even assert that, notwithstanding the necessity to moult, birds have long been endeavouring not only to obtain as brilliant a plumage as possible, but to wear fine feathers all the year round."

Wart disease of potatoes (*Chrysophlyctis endobioticum*) has long been known in this country, but in recent years it has become much more prevalent, owing partly to the popularity of certain varieties of potatoes which are now known to be highly susceptible to the disease. Fortunately for the potato-growing industry in many parts of the country, it has been found that certain varieties of potatoes are absolutely immune. With the view of ascertaining the character of each variety in this respect, the Board of Agriculture has carried out in each of the last three years extensive field trials of varieties at Ormskirk, which is the centre of an important potato-growing district that has suffered serious losses through the ravages of the disease in recent years. A report on the three years' trials has now been published in the November issue of the *Journal of the Board of Agriculture*, and is issued separately as Food Production Leaflet No. 21. The report gives a detailed account of the trials, the results of which are of the greatest practical value. Brief notes on the chief immune varieties are appended.

The fourteenth annual report of the West of Scotland Agricultural College comprises a series of reports on experimental work and other matters which have engaged the attention of the staff. These reports have

been issued as separate bulletins during the past year, and some have already received notice here. Special interest attaches to the report by Prof. R. A. Berry on the results of experiments with cows and dairy produce, of which it is only possible to mention the studies of the variation in the character of milk throughout the lactation period, and the separate study of the changes in the composition of Cheddar cheese during ripening. A further report by Prof. Berry on "The Utilisation and Eradication of Bracken" adds very materially to previous knowledge on this important subject. Special attention must also be directed to the exhaustive report on medicinal plants by Mr. A. Hosking, to which is appended a very comprehensive list of hardy herbs, trees, and shrubs used in medicine. The concluding report by Principal Paterson on experiments in the manuring of oats is very illuminating as to the possibility of raising the average yield of oats in Scotland by the judicious use of manures. The average yield on the fully manured plots in these experiments was about 30 per cent. above that obtained on the unmanured plots, and fully 33 per cent. in advance of the average yield for Scotland.

THE first number has reached us of the *Journal of Dairy Science*. This publication, which is of American origin (Baltimore: Williams and Wilkins Co.; London: Cambridge University Press), is intended to serve as the official organ of the American Dairy Science Association, and to be the medium for scientific discussion of the problems connected with dairying. The value of such a journal, if conducted on the right lines, must be very great, for in it the higher chemical and bacterial questions can be dealt with in a manner which is scarcely possible in the publications which are at present available. The first article in the journal is the text of the address delivered at the opening of the new dairy buildings of the University of Nebraska. The subject-matter of the address is well chosen, and the striking facts brought forward by Prof. R. A. Pearson are worthy of close consideration, particularly at the present time. Messrs. R. S. Breed and W. A. Stocking write on the results of a large number of bacterial analyses of milk. Special attention is directed to the errors which arise in making the counts, and the varying results obtained by the direct and plate methods in the hands of different workers. A very full report is made by the Committee on Statistics of Milk and Cream Regulations regarding the ordinances which obtain in the cities and towns of the United States. This report is of special interest as showing on what lines those responsible for the local administration of dairy laws and regulations are working. It is to be hoped that English dairy investigators will support and contribute to this publication, for the questions they have to elucidate are largely those which concern all nations.

THE Department of Statistics of Calcutta has published vol. ii. of the agricultural statistics of India for 1914–15, which deals with the area under crops, live stock, land revenue assessment, and transfers of land in the Native States. Unfortunately, this volume is much less complete than vol. i., which dealt with British India. The total area of the Native States is given as 777,000 square miles, but agricultural statistics are available only for one-sixth of that area. Detailed statistics are given, however, of the States which furnish returns.

WE have received from the Brooklyn Institute of Arts and Science a copy of a short illustrated guide to the geographical models in the Children's Museum in Bedford Park, Brooklyn, New York. The models, which seem to number eleven, are attempts to present scenes from different lands, so chosen as to illustrate simply and in a striking way the relation of man to his surroundings. The scenes represented are in Greenland, Lapland, Antarctica, the South Seas, Central Australia, the Brazilian forests, the Sahara, East Africa, Patagonia, and the hills of Afghanistan. So far as can be judged by the photographs of the models, they are well executed, but much of their value must necessarily depend on colouring and perspective. No indication of the scale is given, but we gather that the models are life-size.

UNDER the title of "The Use of Mean Sea-level as the Datum for Elevations," Mr. E. L. Jones, of the U.S. Coast and Geodetic Survey, has collected the opinions of a number of engineers and others throughout the United States on the datum to which elevations should be referred. All agreed that mean sea-level should be chosen, and that it should be adopted without further delay. Great confusion arises in some places owing to the number of datum lines used. Thus, in Salt Lake City the corporation, the weather bureau, and the two railway companies all use different levels of reference. To facilitate the adoption of mean sea-level as the standard, Mr. Jones points out that it is essential that precise levelling should be extended over the whole of the United States. At present it is entirely inadequate, being only 1·2 miles per 100 square miles of territory. The extension of the net, as quickly as possible, would allow arbitrary data to be discarded, and would result in increased usefulness in American maps. The paper is published as No. 60 of the United States Coast and Geodetic Survey Series.

As a seismic region, the Middle Mississippi valley will always be of interest owing to the series of great earthquakes which occurred at New Madrid in the years 1811 and 1812. Since then, few years have passed without one or more slight shocks in the district, one of the strongest being that which occurred on April 9 last. This earthquake, which is briefly described by Mr. R. H. Finch in the current Bulletin of the Seismological Society of America (vol. vii., pp. 91–96), is chiefly remarkable for its extensive disturbed area. Though the damage caused by the shock was slight, the earthquake was felt over a district covering about 200,000 square miles. The author infers in consequence that the origin was deeply seated. In the same bulletin Dr. Otto Klotz makes several suggestions for the study of earthquakes in the United States. He insists on the importance of prompt publication of monthly bulletins by the numerous observatories in the country, and recommends the foundation of a central bureau in Washington. Mr. Hamlin's short paper (pp. 113–18) shows how frequently earthquakes are now occurring in southern and eastern California.

ATTENTION may be directed to a very fine geological and topographical atlas of the Gympie Goldfields by the Chief Government Geologist, recently issued by the Queensland Geological Survey. This atlas comprises thirty-six sheets, drawn to the somewhat inconvenient scale of 1/4752, or six chains to the inch, beautifully executed, and apparently worked out in elaborate detail with the utmost care. The district is one of the more important of the goldfields of Queensland, which at one time produced a good deal of alluvial gold, though more recently its output has been chiefly reef-gold, derived from veins of quartz connected genetically, it would seem, with a group of altered diabasic rocks, tuffs, etc. The geological relations of these rocks to the adjoining slates, etc., are well brought out by this series of maps.

THE Geological Survey of Egypt has just issued the third part of its catalogue of invertebrate fossils in the Cairo Museum, by M. R. Fourtau. It comprises the Cretaceous bivalved shells, and is illustrated by seven beautiful plates. As in the previous parts, M. Fourtau uses specific names in a rather wide sense, being convinced that by this means it is easier to appreciate the relationships of a fauna than by multiplying names to denote minute differences. He is also inclined to use familiar and generally adopted names, instead of adhering strictly to the law of priority. His final table, illustrating the geological and geographical distribution of the fossils, includes 170 forms, of which not more than forty-two are peculiar to the Egyptian deposits. Four fresh-water shells are, curiously, found among them. The variable shells of the oysters are especially interesting, and good drawings of these occupy most of the plates. There are parallel variations in the different species depending on the several identical conditions under which they lived. Both the Survey and the author are to be congratulated on the mass of new facts they have brought together, and on the admirable manner in which these are published.

VOL. XXXIII. of the *Compte rendu* of the Société de Physique et d'Histoire Naturelle of Geneva contains a paper by Dr. A. Schidlof on a source of error which may be present in the determination of the electronic charge by Millikan's method. When fine drops of mercury are produced by blowing a gas through the liquid, they are found immediately after production to have a density identical with that of the liquid, but after a time their apparent density decreases considerably owing to the formation of a layer of oxide or of condensed gas on the surface. Dr. Schidlof points out that the same change may occur in the oil drops used by Millikan, and considers that the numbers given by Millikan show a progressive diminution of the electronic charge as the experiments continue, which could be explained by the formation on the oil drops of mean radius $5 \cdot 10^{-4}$ cm. of a layer of thickness 10^{-6} cm., of density 0·3. He considers that the true value of the electronic charge lies between $4 \cdot 775 \times 10^{-10}$ —the value given by Millikan—and $4 \cdot 8 \times 10^{-10}$.

THE Manchester Steam Users' Association has just published its chief engineer's memorandum for 1916–17. Among other subjects discussed by Mr. C. E. Stromeyer is the action of caustic liquors on steel plates. Some rings were cut out of a solid plate, and were bored with a tapering hole; others had a tapering outside, and were forced into the first set of rings so that the external rings were under tension and the internal rings under compression. After treatment in a caustic-soda evaporator, the rings were cut up into small segments, and of each ring one short piece was bent inwards and the other outwards. The results were very consistent. All those which were in a compressed condition when exposed to the caustic bent double without the least sign of cracking; those under tension, when exposed to the caustic, cracked in innumerable places when bent. These cracks appeared both on the outer surface, which was in direct contact with the caustic, and on the inner surface, which was not in contact with the caustic, but was pressing hard against the compressed inner ring. Evidently, therefore, the influence of the caustic had penetrated through $\frac{1}{4}$ in. of metal. Mr. Stromeyer suggests that the action of caustic soda may have been the cause of the cracking of boiler plates in certain instances, and has also several suggestive remarks regarding the design of autoclaves used for the production of certain coal-tar dyes by treatment with strong caustic solutions. A number of autoclaves have been made from drawings found in Continental text-books, and these designs are nearly all faulty.

OUR ASTRONOMICAL COLUMN.

THE APPROACHING SHOWER OF JANUARY METEORS (QUADRANTIDS).—This shower will probably reappear on the nights following January 2 and 3. The best time to observe it will probably be on the early evening of January 3. Mr. T. W. Backhouse, of Sunderland, who has devoted much attention to this meteoric system during a long period of years, concludes that the maximum will occur on the morning of January 3. At that time, however, the gibbous moon will be shining and high in the sky. On the evening of the date mentioned our satellite will not rise until between 10 and 11 p.m., and in the dark sky between about 5.30 and 7 p.m. meteors should be abundant. The radiant point at 232°+52° (8° S. of ι Draconis) will be due north at about 8.40 p.m., at an altitude of only 14° seen from the latitude of Greenwich.

The Quadrantid shower is sometimes very rich, though its principal activity is of very brief duration, and it is seldom well observed owing to the generally clouded English skies at this particular period of the year.

OBSERVATIONS OF β LYRÆ.—A valuable series of observations of the well-known variable star, β Lyræ, has been made at Catania by A. Bemporad (*Mem. Soc. Spett. Ital.*, September–October, 1917). The principal mean results of the observations during 1911–12 are as follows:—

	Mag.	Julian day	Interval in days
First principal minimum ...	4·39	2419,227·51	
			← 3·065
First maximum	3·54	230·575	
			← 3·075
Second minimum	3·87	233·65	
			← 3·700
Second maximum	3·54	237·35	
			← 3·080
Second principal minimum...	4·39	240·43	

The total range of variation was thus 0·85 mag., and there were indications that the second maximum was brighter than the first by about 0·02 mag. While the light-curve about the principal minimum was practically symmetrical, the descent to the secondary minimum was more rapid than the rise to the succeeding maximum.

RADIAL VELOCITIES OF STAR CLUSTERS.—At the Albany meeting of the American Astronomical Society Dr. Slipher announced some important results which he has obtained relating to the radial velocities of star clusters (Journ. R.A.S., Canada, vol. xi., p. 335). The instrumental equipment was that previously employed by him, with marked success, for spiral nebulæ. Ten clusters have been observed, and the velocities range from −410 to +225 km. per sec. The mean velocity, taken without regard to sign, is 150 km. per sec. As in the case of spiral nebulæ, the high velocities observed suggest the possibility that the clusters are distinct from our own sidereal universe.

PARALLAX OF THE RING NEBULA IN LYRA.—An attempt to determine the parallax of the central star of the Lyra nebula has been made by Mr. A. van Maanen, with the aid of photographs taken with the 60-in. reflector at Mt. Wilson (*Popular Astronomy*, vol. xxv., p. 630). Nine comparison stars were utilised, and the resulting relative parallax is given as $+0 \cdot 002'' \pm 0 \cdot 005''$. The absolute parallax would be $0 \cdot 004''$, and as there is practically no doubt as to the association of the star and nebula, this indicates enormous dimensions for the nebula itself, namely, 330 and 250 times the diameter of the orbit of Neptune for the major and minor axes. Taking 14·1 as the visual magnitude of the central star, the above parallax leads to the low value of +7·1 for the absolute magnitude.

AERONAUTICS AND INVENTION.

THE names of the members of the Air Inventions Committee appointed by Lord Cowdray, the late President of the Air Board, were announced last week. They are as follows:—Mr. Horace Darwin, F.R.S. (chairman), Maj.-Gen. Luck, C.B., C.M.G. (vice-chairman), Sir Dugald Clerk, K.B.E., F.R.S., Sir Richard Glazebrook, F.R.S., Prof. H. L. Callendar, F.R.S., Prof. C. H. Lees, F.R.S., Prof. J. E. Petavel, F.R.S., Mr. L. Bairstow, C.B.E., F.R.S., Lt.-Com. Wimperis, R.N.V.R., Major G. Taylor, R.F.C., Capt. B. M. Jones, R.F.C., Capt. A. V. Hill, Munitions Inventions Department, Mr. J. P. Millington, and Mr. F. W. Lanchester. The main function of the Committee is to investigate inventions submitted to it. It will develop and put into operation as soon as possible any invention which promises to add to the efficiency of aircraft. Communications regarding inventions or ideas should be forwarded to the Air Inventions Committee, No. 2 Clement's Inn, W.C.2. There is no doubt that under such an expert Committee any new inventions that may be submitted will be adequately considered and speedily put to practical use if they are of value.

The *Geographical Review* for November, published by the American Geographical Society of New York, contains an excellent article on "Aeronautical Maps and Aerial Transportation," pointing out the great necessity which has arisen for aeronautical maps. Maps are of the utmost importance in naval and military operations, and the recent progress of aviation has made them equally important in aerial warfare. The practicability of long flights was amply demonstrated by the recent bombing expedition carried out by a Handley-Page machine, which flew from England to Constantinople in a series of eight flights, the total distance covered being nearly 2000 miles. To carry out such a flight with certainty the pilot must have good maps of the country over which he is to fly, and they should be special maps showing the country as seen from above, and indicating those landmarks which are most easily identified from a height. The *Geographical Review* gives a brief account of the various types of map in current use for aeronautical work, and prophesies that the work of making an aeronautical map of the world will have to be undertaken in the very near future. The accuracy of aerial photography is mentioned, and it is pointed out that such photography gives an excellent method of mapping a country—a method which is much more rapid than the older surveying processes, and is quite accurate enough for all practical purposes. The question of air routes and their regulation is dealt with at some length, and extensive quotations are given from Lord Montagu's recent lecture on this subject. The main point of interest of the article, however, is that dealing with the necessity of aeronautical maps, as there seems little doubt that the coming of peace will inaugurate a period in which flying will rank as one of the primary means of rapid conveyance, both national and international, and complete maps will then be absolutely indispensable.

Further details of the 2000-mile flight from London to Constantinople have now been made known as a result of a meeting held to celebrate this record flight. Mr. Handley-Page said that the machine used was a Handley-Page twin tractor biplane, fitted with two 275 h.p. Rolls-Royce engines. The weight of the machine "light" was 8000 lb., and fully loaded for flight 14,000 lb., so that the useful load carried—probably including fuel—was 6000 lb. The machine carried a crew of five: the pilot, second pilot, engineer, and two mechanics, together with their luggage and bedding. A very comprehensive set of spare parts was also carried to render the machine independent of local supplies in the event of a breakdown. Amongst other things, three spare radiators, three spare wheels, and two spare propellers were included. This flight to Constantinople is a world's record for a long-distance military flight, but there seems no reason why it should not be repeated, as no very great difficulties seem to have been experienced. The question of vulnerability to attack from the enemy's lighter machines will need careful attention if such flights are to become common. Heavy machines are generally under-powered as compared with light fighters, and have consequently much less climbing speed and flexibility of control. There will probably be a greater need for such machines after the war, and the present achievement leaves no doubt whatever that the employment of large machines for commercial purposes is already within the limits of possibility.

A very interesting article under the title "La Liaison aérienne et la Télégraphie sans Fil en Avion chez les Allemands" appears in *La Nature* for December 8. The importance of an effective liaison between the aeroplanes and their bases in connection with the regulation of artillery fire and the control of infantry attacks is discussed, and the early attempts to attain this end by visual signals is mentioned. Such signals necessitate that the aeroplane should fly practically over its base, and are therefore much limited in application. The method of dropping messages in special tubes suffers from the same disadvantage. For long-distance raids carrier-pigeons have been successfully employed. Wireless telegraphy has now solved the problem satisfactorily for reasonable distances. The reception of messages on the aeroplane has yet to be accomplished, the noise of the engine making the ordinary methods useless, and visual signals are still relied upon as a means of communication from the ground to the machine. The wireless apparatus in use on German machines is very compact and well designed. Current, both continuous and alternating, is supplied by a small generator, driven by an airscrew or "windmill," this method of driving being preferred to direct coupling to the engine, in spite of its lower efficiency, because it enables the set to be used while the machine is gliding with the engine off. The total weight of the wireless set is only 40 lb., and transmission is possible at two different intensities and three different wave-lengths. This provision is made in order that more than one aeroplane may operate in a given area. The range of the set is about twenty-five miles. It is impossible to give full details of the apparatus in this brief notice, but the original article in *La Nature* should be read by all who are interested in the application of wireless telegraphy to fire-control from aircraft.

THE PEOPLING OF MELANESIA.

IN a new work on the anthropogeography of the Pacific,[1] Mr. Churchill returns to the problems which he essayed to solve in his former works on "The Polynesian Wanderings" and "Easter Island" (*cf.* NATURE, August 10 and September 21, 1911, and August 14, 1913). In these he postulated a passage of the Polynesians through the Pacific in two streams, one passing to the north, the other to the south of New Guinea, and meeting in the Samoa-Tonga region, whence they dispersed to the far-eastern Pacific. The present work discusses the migration within and through the Melanesian region.

Sissano is a place on the north of New Guinea, a

1 "Sissano: Movements of Migration within and through Melanesia." By William Churchill. Pp. 181+xvii charts. (Washington: The Carnegie Institution of Washington, 1916.)

little to the east of the Dutch-German boundary. It is regarded by the author as a place of exit for the northern migration from Indonesia, and he quotes in full an account of the people by Neuhauss. A vocabulary in the latter's work, "Neu-Guinea" (probably derived from the trader Schulz, described by Neuhauss as a "drunkard" and by Friederici as "a man of no particular intelligence"), is, when corrected by a shorter list of Friederici's, the basis of Mr. Churchill's argument.

Although the words discussed are so few (about 34), the author belittles the existing Melanesian vocabularies, and suggests (without authority) that others—Codrington, Ray, and Friederici—have based their conclusions on these scanty lists.

Mr. Churchill totally ignores the structure of the languages, and does not distinguish between Melanesian and non-Melanesian languages. His lists of cognate words are designed to show their variation from simple stems which the author finds in the Polynesian forms. Thus *makan*, "eat," is derived from *ani*; *tebu*, "sugar-cane," from *to*. Such derivations are impossible in Indonesian philology. The former presence of Polynesians throughout Indonesia is regarded as established by the tables. The author supposes them to have been expelled from the archipelago by a more cultured people from the mainland of Asia, who assumed some elements of the Polynesian speech.

Mr. Churchill's comparisons of Melanesian and Polynesian words are open to the same objection as those from Indonesia, for he will not admit that Polynesian is secondary to Melanesian. He traverses Friederici's suggestion of a Melanesian migration round the eastern end of New Guinea through Vitiaz Strait (*cf.* NATURE, December 5, 1913). The whole of the eastern part of the south coast of New Guinea is regarded by the author as belonging to Torres Straits, and the languages there are said to be more Polynesian towards the west. For the western part (*i.e.* the *real* Torres Straits region) he says there are no records, and hence he *supposes* that Polynesian survivals may be found there. This is to support the contention of a Polynesian migration through Torres Straits. But all the languages of New Guinea from the narrows of the Straits to the first Melanesian settlements at Cape Possession *are* known, and show no Polynesian survivals.

As to the island region of Melanesia, Mr. Churchill quotes from Dr. Rivers's "Melanesian Society" the chapter on kava and betel, but will not allow a possible origin of the kava culture in Melanesia.

Mr. Churchill's book is interesting, especially in its descriptive parts, and his views as to the directions of the migrations are clearly set forth in a series of charts. He does not disguise the difficulties of his thesis, but his desire to establish the pre-eminence of Polynesian among the languages of the Pacific has caused him to overlook many details which seriously militate against the soundness of his argument.

SIDNEY H. RAY.

CANADIAN EXPLORATION.

SOME information on the work of the Canadian Arctic Expedition additional to that already published appears in the *Geographical Review* for October (vol. iv., No. 4). The whole of the coast-line from Cape Bathurst to the eastern end of Coronation Gulf, except Cape Parry peninsula, was surveyed on a scale of ten miles to an inch. The surveys were extended to include Croker River and Rae River. Other surveys included much of the Mackenzie delta. The most important geological research of the southern party, with whose work this paper by Mr. R. M. Anderson deals, was the investigation of the copper-bearing rocks in the region of Bathurst Inlet. They occur on Banks Peninsula and most of the islands to the north of it. Though the ore so far discovered is of low grade, Dr. O'Neill, the geologist of the expedition, estimated the amount of ore at more than two billion tons, and believes that it can be profitably utilised. Water transport round Alaska would be long and uncertain, but a short railway to Great Bear Lake would probably solve the difficulty of export. The article is illustrated with two sketch maps and a number of valuable photographs.

The Geological Survey of Canada has published, as Memoir 84, a volume by Mr. C. Camsell on an exploration of the Tazin and Taltson Rivers in the North-West Territories. The exploration of this region between Lake Athabaska and the Great Slave Lake was undertaken by the author in 1914 by a canoe traverse from south to north. A compass survey was made and checked almost daily by sextant observations. The report is mainly geological and is accompanied by a geological map on a scale of 8 in. to a mile, and by a number of good illustrations. Neither the Tazin nor the Taltson proves to be navigable, except for short stretches, on account of falls and strong rapids. The country abounds in lakes. The lack of soil, apart from climatic difficulties, makes agriculture impossible. The inhabitants are a few nomadic Indians of the Chipewyan and Dogrib stocks.

EFFECTS OF STORAGE UPON COAL.

A FURTHER contribution to the study of the effect of storage on the properties of bituminous coals has been issued from the Engineering Experimental Station, University of Illinois (Bull. 97). Prof. S. W. Parr, who has been associated with Wheeler, Barker, and Kressman in a series of experiments started in 1910, summarises the conclusions arrived at, and records further investigations; more particularly of interest are those on the action of pyrites and the tests of weathered coals under boilers. The general conclusions that freshly mined coal has a large absorptive capacity for oxygen, the degree being dependent on the character of the coal; that the rate of absorption depends upon fineness of division and temperature; that such oxidation leads to slight increase of temperature, and if not radiated more rapidly than generated the action accelerates to a dangerous point (180° F. is named), have for some time been recognised as the main causes of spontaneous ignition. Parr concludes that the well-recognised loss of thermal value on storage is more apparent than real, being largely due to increase of weight due to oxygen absorption.

Much difference of opinion exists as to the part played by pyrites (FeS_2) in promoting heating. Experiments are recorded showing the increase of soluble sulphates in coal of various grades of fineness on storage. Fine grades show marked increase, but only in one case of coal passing a ten-mesh sieve was any increase noted. It is concluded that to lead to sulphur oxidation two conditions are necessary: fineness of division and presence of moisture. It had been previously shown that the oxidation of 0·5 per cent. of sulphur produced sufficient heat to raise the coal, not allowing for radiation losses, about 125° F. Finely divided pyrites, therefore, may well materially assist in promoting heating by itself, raising the temperature to such a point that oxygen absorption is greatly accelerated. It is shown that whilst the heating value of stored coal is materially reduced, such weathered coal gives over-all boiler efficiencies as high as fresh coal, provided a higher draught is used and the fire kept thin and clear of the water-back of the grate, otherwise clinker trouble is experienced.

THE NITROGEN PROBLEM AND THE WORK OF THE NITROGEN PRODUCTS COMMITTEE.[1]

The Nitrogen Problem.

THE war has served to bring into special prominence the fundamental importance of nitrogen compounds, not only for munitions, but also for agriculture.

Nitrogen is an essential constituent of practically all modern explosives, both of the so-called high-explosives and of propellants. The manufacture of the vast quantities that have been called for by the present conditions of warfare has led to an unprecedented demand for various nitrogen compounds.

Nitrogen is also an essential constituent of all vegetation, and the world's production of food is becoming more and more dependent upon the utilisation of nitrogenous fertilisers. The world's consumption of such materials appears practically to double every ten years, and in 1913 had attained the large figure of 2,500,000 tons of Chile nitrate and about 1,400,000 tons of ammonium sulphate.

With the outbreak of war the demand for explosives became of paramount importance, and the requirements of agriculture for the time being took a secondary position. The prospect of a world shortage of food, however, has served to bring the agricultural aspect of the problem again into the forefront. In this connection it is worthy of note that in 1898 Sir William Crookes, in a carefully reasoned statement, directed attention to the possibility of a shortage in the wheat supply of the world and to the vital bearing upon this question of an adequate supply of nitrogenous fertilisers.

The researches of Sir William Crookes and the experimental work of Lord Rayleigh upon the fixation of atmospheric nitrogen by means of the electric arc pointed the way to a method of utilising the unlimited supply of nitrogen in the air, and thus providing against the time when other natural sources of nitrogen compounds should have become exhausted.

The establishment on a very large scale during the past twenty years of processes for nitrogen fixation is one of the most striking electro-chemical developments of modern times. Special reference may be made to the arc process as used in Norway, the Haber or synthetic ammonia process developed in Germany, and to the cyanamide process for the manufacture of nitrolim from calcium carbide as carried on in Norway, Sweden, France, Italy, Germany, and the United States.

In spite of the fact that the incentive to the commercial establishment of nitrogen fixation may be said to have originated in this country, no steps were taken in the United Kingdom to obtain nitrogen compounds other than cyanides synthetically. The ammonia recovered at gasworks and coke-ovens has constituted practically the only form of combined nitrogen produced in this country. During the war the command of the seas has hitherto enabled Great Britain to rely entirely upon importation for the whole of our supplies of nitrate of soda, the most important raw material of our explosives industry. The Central Powers, on the contrary, having been cut off from external supplies, were compelled to fall back upon their internal resources, with the result that nitrogen fixation processes, some of which were established commercially before the war, have been developed upon an enormous scale.

Formation of the Nitrogen Products Committee.

Soon after the formation of the Munitions Inventions Department in August, 1915, proposals for the fixation of nitrogen began to be received from inventors. These schemes were referred to the Chemical Inventions Committee of the Advisory Panel, but as they were isolated applications of the general problem and were of limited scope, they did not immediately lead to any definite line of policy being taken upon the question. The importance of the problem was recognised, however, and the attention of the Minister was directed to it from time to time in the monthly departmental reports.

The inauguration of the submarine campaign in February, 1916, and the grave menace to overseas supplies of nitrates emphasised the importance of taking action on the matter. At this opportune moment a memorandum on the nitrogen problem was submitted to the Department by the Faraday Society. Several conferences were held to discuss the steps that should be taken, and as a result the Nitrogen Products Committee was constituted in the following June. Members of the Advisory Panel, representatives of other Departments of the Ministry of Munitions and of the Government, and delegates of the leading scientific societies were invited to serve. The terms of reference to the Committee were as follows:—

(1) To consider the relative advantages for this country and for the Empire of the various methods for the fixation of atmospheric nitrogen from the point of view of both war and peace purposes; to ascertain their relative costs, and to advise on proposals relevant thereto which may be submitted to the department.

(2) To examine into the supply of the raw materials required, *e.g.* pure nitrogen and hydrogen, and into the utilisation of the by-products obtained.

(3) Since some of the processes employed depend for their success on the provision of large supplies of cheap power, to ascertain where and how this can best be obtained.

(4) To consider what steps can with advantage be taken to conserve and increase the national resources in nitrogen-bearing compounds and to limit their wastage.

(5) To carry out the experimental work necessary to arrive at definite conclusions as to the practicability and efficiency of such processes as may appear to the Committee to be of value.

(6) As a result of the foregoing steps, to advise as to starting operations on an industrial scale.

Nitrogen Fixation Research.

The necessity for research was evident from the outset, and the department at once took steps for the organisation of a suitable research staff and the acquisition of a laboratory. Fortunately, the co-operation of the authorities of University College was secured, and a part of the new Ramsay Laboratory, at that time scarcely completed, was placed at the disposal of the department.

The item placed first on the research programme was a complete investigation into the production of synthetic ammonia by the Haber process. This decision was influenced by the claims made for the process and by the commanding position it occupies in Germany, where the economic conditions as regards coal supplies and the comparative absence of water-power are similar to those in Great Britain. Moreover, the almost complete lack of precise information concerning the commercial details of this process made it apparent that the research would present many unknown factors, and was therefore likely to occupy a considerable time.

Towards the end of the year the Committee came to the conclusion that the ammonia oxidation process was well adapted as an emergency measure for securing quickly a considerable output of nitric acid or nitrates. Although already working with more or less success

[1] Abridged from a Report printed for the Munitions Inventions Department by H.M. Stationery Office.

upon the Continent, the process had not at that time been operated in this country. A systematic investigation of the most recent developments of the process was therefore undertaken.

Many important problems have arisen in connection with the two main researches indicated above. Reference may be made to such questions as the most efficient and commercially practicable catalysts for the synthesis of ammonia and for ammonia oxidation, and the commercial preparation in bulk and at a sufficiently low cost of hydrogen of the high degree of purity required for the synthesis of ammonia.

Interim Report of the Committee.

In view of the magnitude and complexity of the problem, the Committee was unable immediately to present a complete report. Certain definite conclusions had been arrived at, however, and these, together with recommendations thereon, were embodied in a unanimous interim report, which was submitted to the Minister of Munitions in February, 1917. The substance of the recommendations is given below.

(*a*) *By-product Ammonia.*—The importance of increasing the output of by-product ammonia for munitions and for agriculture was pointed out. Steps were indicated whereby an increase could be obtained from existing gasworks and coke-oven plants. It was also recommended that action should be taken to avoid the loss of ammonia known to be occurring in certain districts.

(*b*) *Ammonia Oxidation Process.*—The erection at the earliest possible moment of plant capable of producing in the aggregate at least 10,000 tons of nitric acid per annum from gasworks or coke-oven ammonia was recommended.

(*c*) *Cyanamide Process.*—The erection of a factory having an annual output of the order of 50,000 tons of cyanamide was recommended, the cyanamide to be utilised as such for agriculture or for the production of ammonia.

(*d*) *Synthetic Ammonia Process.*—The erection of a full-sized trial unit plant for the synthetic ammonia process was recommended.

The Minister of Munitions invited members of the Committee to meet him, and the recommendations of the interim report were discussed in detail. At the conclusion of this meeting the Minister appointed a small Executive Committee to supervise the action involved in giving effect to his decisions, and to report to him from time to time upon the progress made.

The Minister's Decisions and the Action Taken Thereon.

The Minister's decisions were as follows :—

(*a*) *By-product Ammonia.*—The Committee was requested to deal with the problem of conserving ammonia and of augmenting the output on the lines of the recommendations.

(*b*) *Ammonia Oxidation Process.*—The Ministry of Munitions would undertake the installation of one Government plant on the lines suggested, or, if the Committee so advised, the Ministry would agree to the erection of plants by suitable private firms. The information resulting from the research work was to be placed freely at the disposal of *bona-fide* manufacturers, but was not to become the exclusive property of any firm or group of firms.

(*c*) *Cyanamide Process.*—The Committee was requested to investigate the relative merits of a Government scheme and of other schemes that had been put forward involving private enterprise, and to submit a report embodying definite proposals.

(*d*) *Synthetic Ammonia Process.*—The erection of the full-sized trial unit was authorised.

In carrying out these decisions the Executive Committee dealt first with the problem of conserving and increasing the output of by-product ammonia. The next step taken was to summon a conference of manufacturers likely to be interested in the ammonia oxidation process, as a good deal of useful information had been collected regarding it and the research work had already reached a semi-commercial stage. Encouraging progress continued to be made with the research, and arrangements and plans were made for the erection in London of a trial plant consisting of a single commercial unit designed to give an output of one ton of strong nitric acid per day. At this stage the work of establishing the process on a commercial scale for the manufacture of nitric acid and ammonium nitrate was handed over to the Explosives Department at its request in August, 1917. The work of investigation however, has been continued at the research laboratory as several important aspects of the process still remain to be explored.

With regard to the manufacture of cyanamide, the Executive Committee came to the conclusion that the schemes involving private enterprise did not adequately fulfil the ends in view, and recommended the erection of a factory by the Government. The committee proceeded to collect further information on cyanamide processes in actual operation, and representatives proceeded overseas for this purpose. Complete details of a scheme involving a large-scale factory with electric power station are now in course of preparation for submission to the Minister of Munitions.

Meanwhile a considerable amount of work had been carried out in connection with the synthesis of ammonia, including a detailed investigation of the whole of the conditions governing the process, and of the efficiency and life of numerous catalysts. These studies led to the devising of a method of working whereby the output of ammonia per unit of catalyst space has been increased to a figure which, so far as is known, exceeds anything hitherto attained. The design and erection of a semi-technical unit apparatus embodying a number of novel features, with the necessary pumps, circulators, gas-holders, etc., were then undertaken. It is expected that the operation of this unit, which is now at work, will enable the remaining problems as to the chemical engineering details involved in the design of the full-sized trial unit authorised by the Minister to be definitely settled.

Research upon the preparation of pure hydrogen in bulk has been carried on conjointly with the above investigations, and arrangements have already been made for the trial on a semi-commercial scale of a process that has given very promising results in the laboratory.

Nitrogen in Sulphuric Acid Manufacture.

An important practical outcome of the conferences with manufacturers has been the introduction of ammonia oxidation plant to take the place of the nitre-pots used in the manufacture of sulphuric acid by the leaden chamber process. In pre-war times the annual consumption of Chile nitrate for this purpose amounted to 18,000 tons. With the present increased output of sulphuric acid the consumption is greater, so that the possible saving of overseas freight is appreciable.

One of the small converters designed in, and made for, the Departmental Research Laboratory has been installed at the sulphuric acid works of Messrs. Brunner, Mond, and Co., and has been working satisfactorily for some months. The firm is now arranging to adapt similar converters to the whole of their leaden chambers. The United Alkali Co., the South Metropolitan Gas Co., and others are making arrangements to adopt the process, and are utilising two types of converter to the laboratory designs. Drawings have

also been placed at the disposal of the Explosives Department for the benefit of other controlled establishments.

The apparatus is compact; the expense involved in its installation, apart from ammonia purification plant, is comparatively small, and its operation is simple. Arrangements have therefore been made for the rapid manufacture of the converters likely to be required, since it is believed that these designs may become standard types for the purpose in question. An explanatory pamphlet, compiled by the research staff and embodying detailed information concerning the construction and operation of the converters, will be available shortly for the use of firms which have already taken up the process or are desirous of doing so.

Further Research.

Up to the present date the research has practically been confined to the two processes mentioned above and to problems arising therefrom. The investigations of the Committee have shown, however, that many important and promising fields still remain to be explored.

In present circumstances all activities have been concentrated upon processes which have a possible value as war measures, and no attempt has been made to extend the programme of research beyond such limits. In view, however, of the national importance of the nitrogen problem, both now and in the future, it is hoped that definite arrangements will be made to preserve the continuity of the research after the war.

The Importance of Cheap Electric Power.

It was realised from the outset that the generation of electric power at a cost decidedly lower than has hitherto been attained in this country was a vital factor if an attempt was to be made to establish certain of the nitrogen fixation industries in Great Britain on a sound economic basis from the point of view of post-war competition. A thorough inquiry has therefore been made as to the possibility of cheapening the production of electric power from coal, not only by its generation in bulk with the most modern plant, but also by the use of methods involving carbonisation and gasification, with recovery of the ammonia, fuel oils, and other by-products hitherto wasted when raw coal has been directly used. The sub-committees concerned have had the advantage of obtaining the personal views of a number of experts who attended to give evidence on different aspects of the problem. This inquiry has been distinctly fruitful, and much detailed information has been collected.

Schemes for the utilisation of various undeveloped water-powers in the British Isles for nitrogen fixation have also been submitted and carefully examined. At least one of these schemes for hydro-electric development on a considerable scale presents *prima facie* prospects of becoming a valuable national asset. The Power Sub-Committee recommended that a survey should be made of the drainage area in question with the view of confirming the details of the scheme as submitted. The survey has recently been completed and is expected to result in the formulation of a definite development scheme for the utilisation of this water-power. It is estimated that the engineering work involved will take about two years to complete, and the scheme is therefore to be regarded as a post-war measure.

Costs of Operating Nitrogen Fixation Processes.

Since many of the nitrogen fixation processes have not only a value for munitions, but also a post-war importance, endeavours have been made to investigate the probable requirements of this country for nitrogen products. A detailed examination has been made of the production, consumption, imports, and exports of such products, and special consideration has been given to the question as to the relative order of the costs involved in operating the synthetic and non-synthetic processes.

Most of the information relating to synthetic processes has had to be obtained from foreign sources, and the Committee has been able to secure many figures of an authoritative character. The information thus collected has been subjected to critical examination in the light of manufacturing experience in allied industries, and conclusions have been arrived at as to the costs likely to be incurred under British conditions.

The magnitude of this part of the inquiry may be measured when it is stated that the Committee is in possession of comprehensive data concerning the cost of manufacture of :—

(*a*) Nitric acid and nitrates by the older methods, and by the arc and ammonia oxidation processes;

(*b*) Calcium carbide and cyanamide;

(*c*) Ammonia and ammonium sulphate by the Haber and cyanamide processes;

(*d*) Hydrogen and nitrogen;

as well as concerning the costs involved in operating the Chile nitrate and the by-product ammonia industries.

Nitrogen Fixation in the United States.

The action taken by the United States Government on the nitrogen question is worthy of notice. Under the National Defence Act of 1916 a sum of 4,000,000l. was set aside for the establishment in the United States of nitrogen fixation on a large scale. Committees of the National Academy of Sciences, and afterwards of the Ordnance Department, were set up. Their advisers visited England and the more important nitrogen fixation installations on the Continent outside Germany. Upon the recommendation of their experts, the U.S.A. War Department has decided to erect forthwith works for the manufacture of synthetic ammonia by a modified Haber process.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

LEEDS.—At the meeting of the council of the University, held on November 21, the following extract from Prof. Cobb's annual report as Livesey professor and head of the Department of Coal-gas and Fuel Industries was read :—"A valuable donation of carbonising, washing, and purifying plant has been promised, which, in the near future, should prove of very great service to the department and the gas industry; but the erection of the plant must await the conclusion of the war. When installed, this plant is intended to serve as a connecting link between the apparatus of the laboratory and plant on the full working scale. It should allow of the production of any quality of coal-gas and water-gas required for experimental purposes, and will, moreover, from the possibility of exact control and ready modification of its parts, allow studies to be made on the influence of varying conditions of operation which it is hoped will be of a high order of usefulness, both for training and research. For this gift the University is indebted to the generosity of Mr. Henry Woodall, jun., who expresses himself in a letter of June 8, 1917, as happy to provide and erect the plant, 'free of cost, to the University in memory of my late father and partner, whose interest in the University was very deep and sincere.'" The council accepted the offer with great pleasure, and expressed its most sincere thanks to Mr. Woodall for his generous gift.

THE annual meetings of the Geographical Association are to be held on January 5 and 7 next at the

London Day Training College, Southampton Row, W.C.1, and at King's College, Strand, W.C.2. At 11.30 a.m. on the first day Mr. Henry Wilson will lecture on the crafts of Britain, past and future, and at 3 p.m. Mr. W. E. Whitehouse will read a paper on map study in geography and military education. A discussion on geography in advanced courses will be held on January 7 at 10.30 a.m.; and at 5 p.m. on the same day Sir W. M. Ramsay will deliver his presidential address on "The Great Goddess, Mother Earth," at King's College.

THE annual meeting of the Mathematical Association will be held at the London Day Training College, Southampton Row, London, on January 9, at 5.30, and January 10, at 2.30. On the first day, Dr. W. P. Milne will deal with the graphical treatment of power series. On the second day the following subjects will be considered:—Dr. W. P. Milne, the uses and functions of a school mathematical library; Dr. S. Brodetsky, nomography; and Mr. G. Goodwill, some suggestions for a presentation of mathematics in closer touch with reality. Prof. T. P. Nunn will give his presidential address at 2.30, on mathematics and individuality, and this will be followed by a discussion on the position of mathematics in the new scheme of the Board of Education for secondary schools.

THE Education Bill introduced by Mr. Fisher in the House of Commons last August has been withdrawn, but a revised Bill, in which certain amendments have been included, is to be brought forward at an early date during the present session of Parliament. "The new Bill," Mr. Bonar Law, Chancellor of the Exchequer, announced on December 13, "will be taken at the earliest possible moment next session, and I have every reason to hope that it may be possible to pass it into law without delay." The educational clauses of the Bill that has now been allowed to lapse have received the approval of most of the associations concerned with the professional work of education in England, as well as of other representative bodies, and the country looks to the Government to begin national reconstruction on the lines laid down by them. The Bill was, however, heavily weighted with certain administrative proposals dealing with the relations between the Board of Education and local education authorities, and it is these which have met with opposition. Mr. Fisher has introduced substantial changes in the new Bill to meet the objections raised to the administrative clauses of the old one. This encourages us to believe that we are within sight of the day when a long-deferred and much-needed measure of reform of our educational system will find a place in the Statute-book. The importance of making provision for the future by strengthening and extending our educational foundations is acknowledged on all sides, and we are glad to be assured by Mr. Bonar Law that the Government intends to facilitate the progress of this measure of reform through the House of Commons.

THE Education (Scotland) Bill was introduced in the House of Commons on December 17, and was read a first time. The main object of the measure is to effect a further improvement in the provision of education for all classes of the population and to make that provision available to residents in remote and isolated districts. It is proposed to raise the age for full-time school attendance from fourteen to fifteen, and to make attendance at continuation classes obligatory upon pupils between the ages of fifteen and eighteen who were not in full-time attendance in school; to restrict employment both before and after school hours of children attending school, and to regulate still further the employment of children or young persons under the age of fifteen in factories and in mines. The local authorities are empowered to provide books not only for children and young persons who are attending school, but also for adult readers, and provision is further made to ensure that so far as is practicable no child or young person who has promise or ability shall be debarred by reason of difficulty of access or want of means from full opportunity for the development of his faculties by attendance at secondary schools or universities. As there is a large volume of opinion in Scotland which favours the setting up of a body representative of universities, local authorities, teachers, and other classes of persons specially interested in education, as a forum for the discussion of educational questions, provision is made for the constitution of an advisory council, designed to assist the Minister of Education and the Education Department in framing educational proposals.

SOCIETIES AND ACADEMIES.

LONDON.

Linnean Society, November 29.—Sir David Prain, president, in the chair.—Dr. H. **Wager**: (1) Intensity and direction of light as factors in phototropism. In this communication an account is given of experiments made to determine the influence of the intensity and the direction of light in effecting phototropic responses in foliage leaves. The distribution of the physico-chemical activities in the photo-sensitive tissues is dependent upon both intensity and direction of light, and since the direction of movement may be determined as the resultant of the varying physico-chemical activities in the whole of the sensitive region, it must be concluded that both intensity and direction of light are necessary factors in the phototropic response. (2) Spore-coloration in the Agaricaceæ. The use of spore-coloration as a basis for the classification of the Agaricaceæ is artificial and imperfect. There is no clear line of demarcation between the various colours, and the designation of the colours in the text-books is very indefinite and unsatisfactory. A beginning has, however, been made by members of the Mycological Committee of the Yorkshire Naturalists' Union to obtain more accurate records of spore-coloration in terms of a standard series of tints. It has been found—and this may be a fact of some considerable physiological interest—that, with one or two doubtful exceptions, all the spore colours so far standardised, whether pink, rusty, or purple, fall within the region of the less refrangible half of the spectrum. Spectroscopic examination also shows this. It has been suggested by Buller that these colouring matters may serve a useful purpose by screening off certain of the sun's rays from the living protoplasm. Spore-coloration may, however, depend, partly at least, upon the kind of substratum on which the fungi grow.

MANCHESTER.

Literary and Philosophical Society, November 27.—Mr. W. Thomson, president, in the chair.—Prof. W. Boyd **Dawkins**: Examples of pre-Roman bronze-plated iron from the Pilgrim's Way. The examples were an iron snaffle-bit, an iron harness-ring, and an iron hub of a wheel, covered with a thin layer of bronze, discovered in 1895, on the site of a village in Bigbury Wood, about two miles due west of Canterbury. The village is of prehistoric Iron age, and is traversed by the Pilgrim's Way, and has yielded a considerable number of implements to be seen in the Manchester Museum. Of these the three above mentioned are of peculiar interest, because they show that the art of plating iron with bronze was known at that remote period, ranging indefinitely backward from the Roman conquest. The

implements found along with the plated articles consist of iron spears, axes, adzes, hammers, ploughshares, billhooks, and sickles, of the types found in settlements elsewhere of the same age, such as Hunsbury, near Northampton, and the Lake Village at Glastonbury. In addition to these there were also fetters and a chain for a chain-gang of six, with six rings to put round the neck. Similar bronze-plated iron articles have been met with elsewhere.—R. L. **Taylor**: The effect of light on solutions of bleaching powder. Experiments were described in which solutions of bleaching powder, differing in concentration and prepared in different ways, were exposed to diffused daylight and to intermittent bright sunlight, while other similar solutions were kept in the dark. Some of the experiments extended over fifteen months. It was found that solutions exposed to sunlight decomposed quite rapidly, those exposed to diffused daylight much more slowly, while dilute solutions (1 per cent.) kept in the dark remained quite unaltered for the whole period of fifteen months. A solution five times the strength of the latter, however, did undergo some decomposition, losing about 20 per cent. of its available chlorine, even when kept in the dark.

DUBLIN.

Royal Dublin Society, November 27.—Prof. Hugh Ryan in the chair.—Dr. F. E. **Hackett** and R. J. **Feeley**: The polarisation of a Leclanché cell. The recovery of a Leclanché cell from polarisation can be analysed into two parts, a rapid recovery and a slow creep towards the initials E.M.F. The period of rapid recovery can be represented closely by an equation similar to the equation for the decay of ionisation in a gas. The recovery of a Weston cadmium cell from short circuit for a brief interval seems also to obey the same law. The disappearance of polarisation is therefore mainly a bimolecular reaction.—Miss E. J. **Leonard**: The genus Tænitis, with some notes on the remaining Tænitidinæ. The paper is an endeavour to place Tænitis in its true phyletic position, and to find out what relationship, if any, it bears to the other genera classed with it, under the heading Tænitidinæ. Tænitis bears a strong external resemblance to Blechnum, and this resemblance is further supported by many points in its anatomy, such as glandular dermal appendages, the venation of the leaf, and the presence of a commisural vein underlying the sorus. Tænitis is therefore classed as a derivative form in the Blechnoid series. Of the remaining genera, the only one which shows definite relationship to Tænitis is Eschatogramme. The others examined—Drymoglossum, Paltonium, Hymenolepis—are widely divergent, probably in accordance with their epiphytic habit.

BOOKS RECEIVED.

A Supplementary Memoir on British Resources of Sands and Rocks used in Glass Manufacture, with Notes on certain Refractory Materials. By Prof. G. H. Boswell and others. Pp. 92. (London: Longmans and Co.) 3*s.* net.

Telegraph Practice. By J. Lee. Pp. ix+102. (London: Longmans and Co.) 2*s.* 6*d.* net.

Studies in the History and Method of Science. Edited by C. Singer. Pp. xiv+304. (Oxford: At the Clarendon Press.) 21*s.* net.

Meteorological Office. British and Magnetic Year Book, 1915. Part iii., Section 2. (London: Meteorological Office.) 10*s.* net.

National Physical Laboratory. Notes on Screw Gauges. By the Staff of the Gauge-Testing Department. Enlarged issue ii. November. (Teddington: W. F. Parrott.) 2*s.* 6*d.*

Cape Peninsula List of Serials. Being a Catalogue of the Publications available for Consultation in the Libraries of the British Medical Association, etc. Second edition. Pp. 95+iv. (Cape Town: South African Public Library.)

DIARY OF SOCIETIES.

THURSDAY, DECEMBER 20.

INSTITUTION OF MINING AND METALLURGY, at 5.30.—A Neglected Chemical Reaction and an Available Source of Potash: E. A. Ashcroft.—Syphoning Gravel: J. Jervis Garrard.

CHEMICAL SOCIETY, at 8.—Vacuum Balance Cases: B. Blount.—Spark-lengths in Hydrocarbon Gases and Vapours: R. Wright.—Studies of Drying Oils. I. The Properties of some Cerium Salts obtained from Drying Oils: R. S. Morrell.—The Relation of Position Isomerism to Optical Activity. XI. The Menthyl Alkyl Esters of Terephthalic Acid and its Nitro-derivatives: J. B. Cohen and H. S. de Pennington.—Diketohydrindene. III.: A. K. Das and B. N. Ghosh.—Synthesis of Pyranole-derivatives: S. C. Chatterji and B. N. Ghosh.—Synthesis of 3:4-Dihydroxyphenanthrene (Morphol) and of 3:4-Phenanthraquinone: G. Barger.

THURSDAY, DECEMBER 27.

ROYAL INSTITUTION, at 3.—Magnets and the Magnetic Compass: Prof. J. A. Fleming.

SATURDAY, DECEMBER 29.

ROYAL INSTITUTION, at 3.—Electricity and Electric Currents: Prof. J. A. Fleming.

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