THURSDAY, MAY 23, 1918.

MONTESSORI EDUCATIONAL METHODS.

The Advanced Montessori Method: Scientific Pedagogy as Applied to the Education of Children from Seven to Eleven Years. By Maria Montessori. I., *Spontaneous Activity in Education.* Translated from the Italian by F. Simmonds and L. Hutchinson. Pp. vii+357. II., *The Montessori Elementary Material.* Translated from the Italian by A. Livingston. Pp. xviii+455. (London: W. Heinemann, 1918.) Price 8*s.* 6*d.* net and 12*s.* 6*d.* net respectively.

WHATEVER one may think of the fundamental doctrines of Dr. Montessori, her books are always eminently readable. She has a fine enthusiasm for her subject, and a rare fund of anecdotal or biographical illustrations, which are skilfully chosen for the purpose of carrying conviction. An uncritical mind is not censorious about matters of proof. An analogy is as good as a demonstration, and the freedom with which Dr. Montessori relies on analogy reminds one of a famous seventeenth-century educational reformer, Comenius. Of course, her analogies are less crude, but much of her theory and practice rests on an assumed analogy between the mature mind of the adult and the mind of the child. This assumption leads her to the conclusion that since the mature mind does its work in an orderly, logical way, applying to the world around its mechanism of categories which reduces that world to a formal order, so our first business should be to establish definite sensory categories in the mind of the child which shall make the perceptual analysis of his environment orderly and accurate. "It is the qualities of the objects, not the objects themselves, which are important"; so we must train the senses in the accurate discrimination of sensory qualities. This is the object of the didactic materials designed for the use of children from three to six years of age.

Dr. Montessori has little respect for experimental psychology; yet it is worth while noting that Stern's researches showed that children were apparently not natively interested in the qualities of objects until they were past the age of thirteen, and further researches have shown that although children might be trained to observe pictures and the like with special regard to such qualities, when left alone they quickly slip back into what seems to be the natural order of the development of interest—objects as such first of all, then things that are happening, then the spatial and causal relations of objects, and latest of all their qualities.

Unfortunately, Dr. Montessori never gives the evidence on which her conclusions are based. A pretty story does not establish a principle. This defect in her books is the more noteworthy because she has presumably had a scientific training and because she explicitly claims that her results are arrived at by exact methods. A chapter headed rather naïvely "My Contributions to Experimental Science" would surely make any person acquainted with rigorous scientific method smile. As a summary of results for popular consumption, it is not without merit, but one seeks in vain for references to the original memoirs in which the detailed work is carefully described and where the conclusions are adequately discussed. She is so acute a critic of the work of others that we might at least expect her to take as much pains as they have done to make her whole method of investigation and its detailed results accessible to scientific criticism. Popular books are necessary, but they must rest upon a solid basis of carefully recorded fact if they are to stand the test of time.

Apart from this grave defect in the Montessori literature, judged from the point of view of a scientific pedagogy, there is so much humanity in it that we must do homage to its distinguished author for her service to the cause of humane education. She enjoys flogging a dead horse (or should we say a dying horse?), apparently believing that it is still in vigorous life. She is so wrapt up in her own work that she is unaware of the great changes which the biological conception of education was bringing about in our schools before we had heard her name. But a remarkable business talent has obtained for her a hearing such as few educational writers in English-speaking countries enjoy. Where one person has heard the name of Dewey, a thousand have heard that of Montessori, and we may rejoice to think of the numbers who will read the chapters in this book on the will and the intelligence.

It is in the second volume that the application of the Montessori method to the primary school is described. There is much suggestive matter in its chapters, though very little that is new, except perhaps the "didactic materials." The author believes that teachers should be supplied with the material necessary to enable the children of themselves to achieve a desired result. This material should have been determined experimentally, and, once it has been designed, the teacher has only to make himself thoroughly familiar with its use. So we find the words and sentences for the grammar work are provided. They are carefully graduated and laid out in neat boxes. One is irresistibly reminded of Pestalozzi's ambitious designs. Get the mechanism right and train your teachers in the use of it, then all will be well. Of course, the mechanism is the result of experimental inquiry, as was Pestalozzi's, but, in spite of the charm with which it is described, we fear it will share the same fate as Froebel's gifts and Pestalozzi's A B C's.

Rather more than a third of the volume is given to grammar. Under the stimulus of the apparatus, children of eleven are led to distinguish eight kinds of adverbs and fourteen kinds of conjunctions, but the apparatus for arithmetic only carries them to a stage which a good Standard III. child in an English school would find easy. The rest of the book deals with geometry, music,

rhythm, and verse structure. The range of the last may be gathered from its concluding paragraph, which tells us that "the child is now ready for the more difficult problems of anacrusis, catalexis, irregular feet, and irregular pauses." There is nothing of history or geography in the book. No doubt the didactic materials are still in preparation. J. A. G.

MODERN INDUSTRY.

(1) *What Industry Owes to Chemical Science.* By R. B. Pilcher and F. Butler-Jones. With an introduction by Sir G. Beilby. Pp. xiv+150. (London: Constable and Co., Ltd., 1918.) Price 3*s.* net.

(2) *Some Problems of Modern Industry: Being the Watt University Lecture for* 1918. By W. C. Hichens. Pp. 61. (London: Nisbet and Co., Ltd., 1918.) Price 6*d.* net.

(1) IF British trade is to hold its own in face of the acute competition which is to be expected, great alterations must be effected, and these two books point out some directions in which improvements may be made. Messrs. Pilcher and Butler-Jones's handbook is a capital *résumé* of the improvements made in metallurgy and in the manufacture of dyes, explosives, glass, pottery, and many other commodities by the application of scientific research. It is very readable, and gives in a handy form an accurate and interesting account of the growth and results of industrial chemistry. It shows how much we owe to British and French chemists, and avoids a common mistake which gives the main credit in this matter to Germany. It is the most compact and convenient history of industrial chemistry which we have come across. As a rule, the authors have kept to general principles, and this is wise, because the book is not intended for experts in each particular trade, but for the public as a whole, and because no one or two men can write on the various industries concerned with first-hand knowledge of all, but must depend on other books for a large part of the information.

In some cases, where the authors have gone into detail—for example, in describing the Pattinson and Parkes processes for lead refining—the details show that the authors have no recent actual experience of the methods employed in this country, but have probably relied on text-books. In dealing with monazite sand the large and rich deposits in the south of India might be mentioned, and the successful diversion of these sources from German hands to our own. In relation to the competition between artificial and natural indigo the recent action of the Indian Government in applying modern scientific methods to the production and marketing of natural indigo should be recognised. Would that all Governments and Government Departments were equally broad-minded and far-seeing! In this country the permanent Government officials are usually recruited from a class which, though aware of the importance of chemistry, is so out of touch with chemists, and so lacking in sympathy with chemical ideas, that it is hard for them to realise what is really required by the country. The average Member of Parliament and the average man of business do not recognise that a first-class man of science is, as a rule, valuable only in his own subject. Messrs. Pilcher and Butler-Jones's book will show the public at large how enormous the science has become, and how stupid it is to expect an electrician to be an authority on paraffin oils, or a genius in spectroscopic work on gases to be a sound guide in the manufacture of artificial rubber.

(2) As chairman of Cammell, Laird, and Co., Mr. Hichens is able to look at modern industry in a broad manner. He deals mainly with ethical questions, the relations with labour, conditions of work, the right of the State to a share in profits, and so on. He has a pleasant style of writing, and his commercial training has not destroyed his power of refreshing his mind and the minds of his audience by recalling some picture of a bygone age before trade-unions or excess profits were thought of. It is impossible in an hour's lecture to do more than indicate the sort of problem to be tackled. Mr. Hichens has done this in an agreeable and interesting manner, and his lecture should appeal to all students of social problems.

BALLISTICS.

Text-book of Ordnance and Gunnery. By Lt.-Col. W. H. Tschappat. Pp. x+705. (New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1917.) Price 30*s.* net.

AT no previous time in history has so much attention been paid to artillery as during the present war. The unprecedented number and variety of guns in use enable a mass of evidence, sufficient to prove or disprove any theory which is considered worthy of a practical trial, to be accumulated in a very short space of time. Moreover, it is almost certain that all the belligerent countries are liberally spending money on researches into the various branches of the art of gunnery, and employing, for this purpose, more men of scientific reputation and mechanical genius than have ever considered the subject seriously before. As a natural consequence, "ordnance and gunnery" must be in a state of rapid development, and it would therefore appear to be a somewhat unfortunate moment for the publication of Col. Tschappat's book, which is, so largely, merely a revision of an excellent book with the same title by Lt.-Col. Lissak.

That the revision has effected a decided improvement cannot be denied, but there is little that is new, of any importance, to be found in it. The major alteration is in the treatment of interior ballistics. Col. Lissak used Ingall's method. In the volume under review a carefully elaborated method of producing the pressure and velocity curves by integrating the energy equations is presented. The method has the advantage that a complete calculation of a gun can be made without any firing data, but the process seems laborious, and there does not seem to be any means provided for quickly finding the point

of maximum pressure. This must lead to considerable labour when finding the best relation between the capacities of chamber and bore for a new type of gun.

Other additions to Col. Lissak's text are: descriptions of the manufacture of the American nitrocellulose powder; the modern hydro-pneumatic recoil systems; the 12-in. mortar carriage, model 1908; and the Lewis air-cooled machine-gun. Otherwise Col. Lissak's text has been largely adhered to, but the subjects have been rearranged in a more logical sequence.

The chapter on interior ballistics is marred by the number of errors in the formulæ which have escaped notice.

OUR BOOKSHELF.

Equipment for the Farm and the Farmstead. By Prof. H. C. Ramsower. Pp. xii+523. (Boston, Mass.; London, etc.: Ginn and Co., 1917.) Price 10*s.* 6*d.* net.

IN this volume Prof. Ramsower has broken new ground and given us an account of the equipment necessary for starting and maintaining a farm in the United States, with special reference to the conditions in the Middle West. About half of the book deals with the construction of the farmhouse and buildings, and the other half with farm implements. As material for construction about the farm, Prof. Ramsower recognises the great advantage of concrete, though he also realises its disadvantages. There is an interesting chapter on the lighting of the farmhouse. Water supply and sewage are also dealt with at length, and considerable stress is laid on the need for adequate sanitation.

The remainder of the book deals with farm implements. The plough comes first as the basal tillage tool, "walking" ploughs and "sulky" ploughs being both described. The former is the type commonly seen in this country when the ploughman has to walk; the "sulky" plough, on the other hand, allows him to ride; it takes its name from the light two-wheeled carriage used in America, and is called a "sulky" because it accommodates only one. The difference between them lies in the amount of friction; the ordinary plough rests on a smooth slade or sole, which slips over the ground; the "sulky" plough, on the other hand, rests on wheels. Thus, the sliding friction of the ordinary plough is replaced by rolling friction, and, in consequence, it is possible to add the weight of the frame and the driver without materially damaging the draft of the plough.

Harrows are dealt with at length: the spike-tooth forms, as commonly seen here, and the spring-tine and the disc forms, which seem to have great possibilities. There is also a useful chapter on the gasolene and oil engine, in which the author describes not only the engines themselves, but also some of the many troubles which arise directly an engine or tractor is set to work on a farm.

The book is well illustrated, and will be found very helpful to serious farm students.

Everyday Physics: A Laboratory Manual. By J. C. Packard. Pp. vi+136. (Boston, Mass.; London, etc.: Ginn and Co., 1917.) Price 4*s.* 6*d.* net.

A LABORATORY manual outlining a course in physics "adapted equally well to preparation for college and to the immediate requirements of everyday life" may be regarded as a sign of the times. It is becoming recognised in an increasing degree that the fundamental principles of physical science must be employed not only in the laboratory, but also in the home and in the factory. Mr. Packard, who is science master at the High School, Brookline, Massachusetts, has produced a volume of considerable interest and originality, which may be recommended to teachers who are planning a practical course in science for a secondary school. More than sixty exercises are given, covering a wide range of subjects, the usual experiments in a physics course being combined with newer exercises involving the use of commercial apparatus. Thus we have not only a "Study of a Metric Rule," but also a "Study of a Water Meter," with instructions for testing the accuracy of the meter by filling a tank of which the dimensions are to be determined. This is followed by exercises on gas and electricity meters with clearly drawn diagrams for each case.

A few of the more novel subjects studied include a water motor, a life preserver (illustrating the principle of Archimedes), an anemometer, a gas or alcohol stove, methods of domestic heating, lighting, and ventilation, the mechanism and action of a clock and of a sewing machine. Nearly every exercise is preceded by an introduction, intended to show the bearing of the topic in hand upon related subjects, and is followed by questions or problems emphasising the immediate application of the principle involved to the affairs of daily life. Topics for further study and investigation are suggested, and the author points out that much valuable material for every department of science can be gathered from trade catalogues. The student is instructed as to the best method of recording the results of his observations, but, as the author rightly says, the object of a laboratory course in physics is not to make a note-book, but to teach the principles of physics and to emphasise their practical application. H. S. A.

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.*]

The Supposed "Fascination" of Birds by Snakes.

I HAVE now received a reply from Capt. G. D. H. Carpenter to my letter suggesting that he had observed an instance of "mobbing." It was written in January last from Lulanguru, seventeen miles east of Tabora, in ex-German East Africa:—

"Regarding my snake and bird observation, the birds' behaviour was quite unmistakable; they were

not looking for food or anything else, and did literally appear to be 'scared stiff,' as one might say. If it was mobbing, it was very different from such active mobbing as I have seen—one might call it 'passive mobbing,' for there was no attempt at offence either by word or deed. The feeble chirps sounded more like a faint protest than anything else."

It must be remembered, as Mr. S. A. Neave has pointed out to me, that in such cases the presence of numbers is in itself disconcerting, however feeble may be the powers of the mobbers. Capt. Carpenter's description suggests that the snake was disturbed and harassed.

I was mistaken in supposing that Mr. F. Muir's observation (quoted in NATURE of January 17, p. 385) was made in East Africa. He informs me that it was in Amboyna in the latter part of 1907 or early in 1908. Mr. Muir writes:—

"Is it not possible that birds are paralysed with fear rather than 'fascinated' in such cases? I had a parrot in Africa (now living at Brockenhurst with Dr. Sharp's family) which would fall off her perch if a dead or living snake was brought near to her; even a piece of rope suddenly brought into view would produce a fright which would paralyse her and prevent her even from screaming."

I have just received the following interesting record of observations by Mr. C. F. M. Swynnerton, writing from Chirinda, South-East Rhodesia:—

"March 29, 1918.

"For more than a year past I have lived in a house in an open space, but our old house was closely surrounded by trees, and, in the breeding season particularly, the mobbing of tree-snakes by birds was often, for a week or ten days together, a daily occurrence.

"Birds probably mob tree-snakes whenever they detect them, for I have seen such mobbings both out of the breeding season and when I was unable by a careful search to find a nest; but in most cases where a nest was concerned the birds—most commonly bulbuls in my observations—that were the parents of the fledglings were the first to detect the snake's approach to the nest and to start the hue and cry. Shrikes, sunbirds, flycatchers, warblers—in fact, any bird that happened to be near—would quickly join in and mob the snake, scolding all round it and occasionally darting in at it in the very manner in which they mob an owl. The mobbers remain, for the most part, out of striking distance of the snake, but some—and this applies especially, in my observations, to the 'puff-back shrike' (*Dryoscopus cubla*)—are very bold, both in the matter of darting in and in staying near the snake. A bird perched in front of the snake, as I have sometimes seen it, with its wings drooping and quivering with excitement, might well be taken by an ignorant person, who did not follow his observations up, to be fascinated by it; whereas it is, in reality, busy hurling at the snake every unpleasant name it can lay its tongue to. The mobbing sometimes continues for half an hour, sometimes for much longer, though the individual mobbers do not always—with the exception of the owners of the threatened nest—remain the same. Some tire and go off—anyway, temporarily—and their places are taken by others. The snake in general appears to take little notice of the birds, though it will commonly face a specially bold one; and I have seen it lunge sometimes, but unsuccessfully. Were it to succeed, I suppose the believer in fascination would be confirmed in his belief. Probably, too, even when apparently indifferent, it is sometimes embarrassed and delayed, for it will sometimes stay quite still for long together—except for the constant flickering of the tongue. When it reaches the nest there is a great scene on the part of the parents, and they lose any fear of the snake they may have had before in their attempts to save their young. The latter, if nearly fledged, generally take fright as the result of their parents' actions, and not (as I have proved experimentally) from any instinctive fear of the snake, and flutter down. I have seen little bulbuls come down thus unharmed from a nest 50 ft. up. Mostly I have shot the snakes before they have reached the nest, but I have seen young birds taken, and I have also taken them from inside snakes that had left a nest or were coiled about it. The snake in nearly every case has been *Disphoridus typus*, I believe, for I do not remember if I have actually taken it to Mr. Boulenger.

"For two or three seasons I watched all the mobbings I could, as I had noticed in the case of birds of which I knew the courting display that this tended to be repeated under the excitement of mobbing, and I felt that the converse would also be true. So I watched in order to get the displays of the different species. I obtained in this way a certain number of notes, but these do not bear on your question, referring, I believe, solely to this matter of display. The watching of these mobbings of snakes—which I supposed were well known—long ago convinced me that there was nothing at all in the 'fascination' idea. The birds show great daring and insolence, and it is hatred and indignation, and perhaps partly the desire to assist, and not 'fascination,' that draws them to the snake. It is the same, I believe, in the case of hawks and owls—for the birds will certainly recognise the latter as an enemy, apart from its rough resemblance to a hawk. I have taken a freshly eaten bird from an owl's stomach (*Syrnium woodfordi*) when it was barely twilight and small birds were still active." EDWARD B. POULTON.

Oxford, May 6.

As I was correcting the proofs of the above, the following letter from Capt. Carpenter reached me. The behaviour observed by him is, I believe, to be interpreted as due to the interplay between two opposing impulses, both beneficial—one based on the fear of snakes, the other on social stimuli which incite to combination for the purpose of harassing an enemy. It is only to be expected that such interplay will lead to different behaviour with different species of bird, and perhaps with the same species in the presence of different types of snake. Differences are, above all, caused, as Mr. Swynnerton shows, by the behaviour of the snake, which, when it attacks the nest, brings in a third impulse—the defence of offspring—and leads the parent birds to act as though they were altogether without fear. E. B. P.

May 13.

"I have only recently received the copy of NATURE for November 29, 1917, in which you printed Prof. Poulton's letter commenting on an observation of mine on the subject of 'fascination' of birds by snakes. Prof. Poulton suggested that this was a case of 'mobbing,' and has just sent me a proof of his second communication on this subject, giving instances of 'mobbing' noted by field naturalists.

"I wish to direct attention to the following point:—The mobbing of a snake or a bird of prey is most definitely a *voluntary* act on the part of the small birds.

"In the case which I described, however, the behaviour of the little finches strongly suggested that they were there *against* their will, or perhaps one should say their better judgment.

"The 'faint chirps' which I described were not the

sounds uttered by angry birds, but like those that might be made as a feeble protest against some overpowering influence; and the whole behaviour of the birds was utterly unlike that of a crowd deliberately mobbing a bird of prey with angry noises. I have witnessed this on several occasions, but have not seen a similar demonstration against a snake.

"I would ask readers to note, in the professor's second letter, the difference in the behaviour of the birds from that which I have described.

"Mr. Kershaw speaks of 'a great hubbub'; Mr. Hockin of the birds as 'shrieking for all they were worth.' This is surely something of a very different order from the 'faint chirps' of apparently unwilling birds which I heard. Indeed, they at once reminded me of the nightmare in which one attempts to cry out and run away, and can do neither!

"I still believe that it was a case of 'fascination,' although I do not for an instant imply that it was by some mysterious power emanating from the snake.

"May it not be analogous to the strange fascination which the morbid and terrible have for some human beings?

"There are individuals who have a horror of going near to the top of a precipice, for they feel as if they must throw themselves over, yet at the same time they feel constrained to go and look at the chasm which 'fascinates' them. G. H. HALE CARPENTER.

"c/o Medical G.H.Q., Dar es Salaam,
March 12."

SCIENTIFIC TESTS FOR THE SELECTION OF PILOTS FOR THE AIR FORCE.

MODERN aviation by its complex evolutions in a rarefied atmosphere imposes an enormous strain upon the bodily mechanisms. It is important, therefore, that the subjects selected for such work shall be in every way fitted for it, otherwise early breakdown or worse may result to the would-be pilot, in addition to needless expense to the country. The problem of the selection of fit candidates is therefore best approached from the point of view of practical aeronautics.

Considering the effects of a flight in detail, with increasing altitude there is in the first place a deepening of the respiration necessary to secure an adequate oxygen supply. Later, the pulse quickens, and, since a quickened rate of heart-beat entails increased oxygen consumption, there is established a vicious circle—namely, an increased oxygen consumption with a progressively diminishing supply. Therefore, all the bodily devices that render the respiration and the circulation efficient will be called into play—in particular the nervous mechanisms controlling the respiration and circulation. Finally, at great altitudes loss of muscular power and nervous symptoms, subjective and objective, supervene, so that the pilot or observer finds it difficult to perform his work efficiently.

In addition to the effects of altitude, there is, as regards the nervous system, the psychical strain involved during preliminary training, the anxiety of the first solo flights, and, finally, the stress of combatant service. For these reasons it is evident that the candidates for aviation must be of the fittest. As is to be expected, therefore, past experience has shown that candidates with a good physique and previous excellence at sports make the best pilots.

Considering the examination of candidates in more detail, it is important first of all that the candidate shall be able to withstand the effects of work in a rarefied atmosphere. No matter how sound in body and limb, a candidate for the Air Force is useless if he will not wear well under these conditions. From this point of view it is to be borne in mind that previous knowledge of mountain sickness and life at high altitudes is of little service, as there is no evidence of any acclimatisation to altitude in the flying officer.

At the Aviation Candidates' Board particular attention is devoted to the respiratory system, where, in addition to good, healthy lungs and an efficient vital capacity, it is deemed necessary for the candidate to be able to hold the breath for a considerable period of time. In regard to the last test, it has been shown by careful correlation with more complex tests that the power to hold the breath is closely related to the capacity of the candidate to bear the strain of high altitudes.

In addition to an organically sound heart, it is also deemed essential by this Board that the heart shall respond efficiently to work both in respect of increase of pulse-rate and time of return to the normal. This is tested by getting the candidate to step from the ground on to a chair five times in fifteen seconds. The increase in pulse-rate is noted, and the time of return to the rate before the exercise carefully observed. The standards for this test have been set by the examination of a number of successful pilots.

As regards the circulatory standard, it is held that the difference between the pressure in the circulatory system when the heart is beating and the pressure when the heart is resting shall not be great (more than 50 mm. Hg), nor the latter pressure (the diastolic pressure) too low (below 70 mm. Hg).

In regard to the nervous system, besides signs of good nervous stability, it is deemed important that the candidate shall have accurate vision; and examination is particularly directed to rule out cases of concealed hypermetropia, which involves bad landing. A good colour sense is also necessary.

In Allied countries especial attention has been directed to the examination of the labyrinthine mechanism. Although practised, such tests have not so great a vogue in this country. It is to be remarked that, as carried out by means of the revolving chair, the labyrinthine tests yield information in regard to the horizontal canals, whereas in most aerial "stunts" it is the superior canal which is important to the airman. Therefore, if tests for this mechanism be employed in great detail, they should also be directed to the investigation of the superior canal.

A further criticism of these tests is that they are based largely on theoretical considerations, and before standards are adopted in regard to such it is important that a series of healthy and successful pilots should be examined. Since aviators may emerge from a cloud "on their backs" (that is,

with the machine upside down), it is still a matter of contention as to the absolute degree of efficiency which is required in regard to the labyrinthine mechanism.

On the other hand, in regard to the aural examination, it is beyond doubt that the candidate must have good hearing, if only to detect the noise of defective working of his machine, and also healthy tympanic membranes and uncongested Eustachian tubes, so that he may readily adapt himself to varying changes of pressure.

Good muscular sense is of great importance in a candidate, since there is reason to believe that normally this plays intuitively a considerable part in the accurate balance of a pilot and his machine. Particular attention, therefore, is directed to this point at the British Aviation Candidates' Board.

In regard to reaction times these have been fully investigated by the French authorities, but with the present large demand for candidates for the Air Force it is impossible and unnecessary to carry out such tests in great detail, since during his training this is done to a certain extent by his instructor, and the candidate eventually allotted to the type of machine for which, in this respect, he is found most suitable. This, however, does not mean that such tests should not be applied in special cases.

The flying temperament, it must be confessed, rather baffles assessment, and at the present time it is difficult to eliminate the candidate who may develop an "anxiety neurosis," and therefore later become unsuitable for flying.

Valuable information is obtained from previous medical history, and, to a certain extent, from family history; it is deemed inadvisable, as a general rule, to accept any candidate who has a previous history of serious respiratory trouble or nervous breakdown of any kind. In regard to a history of concussion, however, it has been found that 40 per cent. of successful pilots give a history of concussion of varying duration. Therefore, if at the time of examination there are no signs of nervous instability, it shows that the candidate has a nervous system which can recover well from the effects of concussion. Also the history of the accident leading to such concussion frequently reveals a degree of enthusiastic recklessness characteristic of the "flying" temperament, and for this reason the subject is likely to make a good pilot.

MARTIN FLACK.

THE ZINC ORE RESOURCES OF THE EMPIRE.

THE Mineral Resources Committee of the Imperial Institute has arranged for the publication of a series of monographs on the mineral resources of the Empire, of which the first, dealing with zinc ores, is now issued. Copies of this monograph are obtainable at 2*s*. each, post free, from the Imperial Institute.

Mr. S. J. Johnstone has been chiefly responsible for the work of compilation, and Mr. T. Cook for that of general revision. They have been assisted by Mr. W. S. Robinson, vice-president of the Australian Metal Exchange, and a member of the Imperial Institute Committee for Australia.

In issuing these monographs, the aim of the committee is stated to be not so much to cater for the specialist as to diffuse knowledge of the Empire's mineral resources among those who control and sell them and those who use the products to which they give rise, in the hope that the dissemination of such information will lead to a greater utilisation of these resources within the Empire itself than has been the case in the past.

Although large quantities of zinc ore were mined in the Empire before the war, nearly all the product was exported to and smelted in Germany and Belgium. Thus in 1913, although the Empire produced 20 per cent. of the world's output of zinc ores, its total production of the metal (spelter) was only 6·4 per cent. of the world's output, and not quite half of this was primary or virgin spelter, the remainder being secondary (remelted) metal. Germany and Belgium, on the other hand, produced about 48 per cent. of the world's annual supply of spelter, although they themselves contributed only 23 per cent. of the world's output of zinc ore, the rest of their supplies being obtained from the famous Broken Hill concentrates shipped from Australia.

In the last pre-war year Germany led the way in ore-production, followed by New South Wales, the United States of America, Spain, and Italy, in order of magnitude. These are the principal ore-producing countries.

The most important ore-minerals of zinc are the sulphide, ZnS, known as zincblende and also as sphalerite, and the carbonate, $ZnCO_3$, known as calamine and sometimes also as Smithsonite; the former is by far the more important source of the metal. Special mention should also be made of Franklinite, a mangano-ferrate of iron, manganese, and zinc, found in large quantities in New Jersey, U.S.A., which is a source not only of zinc, but also of ferromanganese. The silicate ore, hemimorphite, $3ZnOSiO_2 + H_2O$, also serves as one of the minor sources of the metal.

Zinc ores occur, and have been mined for some time, in many parts of the United Kingdom; of these a considerable proportion were *exported* before the war to the Continent for smelting. On the other hand, ores from foreign countries have, at the same time, been *imported* and smelted here, a condition of things which would be incredible if it were not true.

The most considerable source of zinc ore in the Empire is the deposit in the Broken Hill district, New South Wales, which is situated at the southern extremity of the Barrier range. The extreme length of the ore-bearing ridge is about two miles, and the report gives information as to how the ore changes in passing from the oxidised outcrop to the unaltered sulphide minerals below.

Stated very briefly, this monograph gives, in the first place, a short statistical account of the world's production of zinc ores and zinc, and describes the ore-minerals; then follows a section devoted to the principal ore-deposits of the Em-

pire, special attention being given to Australia, the United Kingdom, Canada, and India, which are the principal British sources of supply; next come references to the more important deposits in foreign countries; then follow sections dealing with the valuation, concentration, and smelting of the ores, the various types of the commercial metal (spelter), with references to impurities, grades, and prices; the final section deals with the properties and utilisation of the metal, whether as such, in the form of alloys, or pigments.

There is an obvious misprint on p. 54 where it is stated that the distillation retorts are "about 8 ft. in diameter." *For* "feet" *read* "inches."

THE DECLINE IN THE BIRTH-RATE.

IN a judicial way Dr. Millard discusses, in the paper before us,[1] the problem of the fall of the birth-rate in its relation to social welfare. He does not share the orthodox view that the decline of the birth-rate is in itself a deplorable fact, or that deliberate birth-control is necessarily to be regarded with disapprobation. On the contrary, he advances substantial arguments in support of the following conclusions. The fall in the birth-rate is a general phenomenon among civilised nations. It is due, not to diminished natural fertility, but to deliberate birth-control. It is not in itself an evidence of national decadence; it may be an expression of advancing civilisation—of a more conscious control of life. Birth-control is the civilised substitute for those natural checks to the rapid growth of population—scarcity, disease, and war—which have always operated in the past. Rapidly growing populations in countries with circumscribed territories are apt to give rise to political unrest and to serve as provocatives to war. International competition in birth-rates is correlated with a competition in armaments, and both are undesirable.

The prosperity of Britain is at present wrapped up with the abundant supply of cheap coal, and the more rapidly the population of this country increases, the sooner will the beginning of the end of our coal-fields manifest itself. To postpone the approach of what the author calls the dark and gloomy epoch (who knows what other stores of energy may not be tapped before the coal is exhausted?), an increased birth-control may usefully operate. But there are more immediate reasons for advocating birth-control. It is far from being race-suicide; it is a natural ally of the maternity and child welfare movement. A low birth-rate is closely correlated with a low rate of infantile mortality. A high birth-rate usually means great infantile mortality. "Birth-control is an essential factor in the campaign against poverty. It is calculated to reduce the supply of unskilled labour, to increase efficiency, to raise wages, and to encourage a higher standard of life." It seems almost as sure a panacea as Prohibition!

[1] "Population and Birth-Control." Presidential address to the Leicester Literary and Philosophical Society, 1917. By Dr. C. Killick Millard. Pp. 48. (Leicester, 1917.) Price 1*s*.

We think, indeed, that Dr. Millard is altogether too enthusiastic over birth-control as we know it at present. Perhaps its methods are improving; but there seems more than a touch of irony in the statement that married people, if in doubt as to the best methods of birth-control to be adopted, "will naturally look to the medical profession for advice." How abundant and helpful that expert advice has been during the last quarter of a century!

The author has a fine passage on the joy and discipline of parenthood, and we agree with him that the availability of trustworthy counsel will encourage early marriages, which are on the victory side, we hope, in the campaign against "immorality" and venereal diseases. In any case, there is much to be said for Dr. Millard's summing-up, that "properly used, and not abused, birth-control is a valuable eugenic instrument, capable, by restricting the multiplication of the least fit, of greatly raising the quality of the race."

SIR ALEXANDER PEDLER, F.R.S.

THE announcement of the sudden death of Sir Alexander Pedler, while attending a Committee meeting at the Ministry of Munitions on Monday, May 13, came as a shock and great surprise to his many friends. There had been, among the majority of them, no suspicion of weakness, and to all appearance he was a man who might confidently look forward to many more years of useful work.

Pedler received his early education at the City of London School. The present writer made his acquaintance in October, 1866, when, at the age of seventeen, he won a Bell scholarship and began work as a student in the laboratory of the Pharmaceutical Society. Here he went through the usual course of analytical work, and at the end of the session was awarded a certificate of honour in practical chemistry. Before leaving, he began a piece of research suggested to him by the writer, who was then demonstrator in the school. It was with great regret that he parted with the promising young student, who had, by this time, decided to leave the comparatively narrow field of pharmacy and proceeded to place himself under Prof. (afterwards Sir Edward) Frankland at the Royal College of Chemistry, then in Oxford Street. There he soon entered on research and carried out the separation of the amylic alcohols by Pasteur's process. From the optically active and inactive alcohols thus obtained he prepared the corresponding valeric acids, and gave an account of the work to the Chemical Society in 1868 (J. Chem. Soc., N.S. 6, 74). Further work in this direction was interrupted by his taking part in the solar eclipse expedition of that year.

From 1871 Pedler served for two years as lecture demonstrator to Sir Edward Frankland in the Royal College of Chemistry in succession to Mr. Herbert McLeod, who had been appointed to the professorship of chemistry in the then newly instituted Royal Engineering College at Coopers

Hill. At that time he assisted in the research work on gaseous spectra in which Sir Edward Frankland and Sir Norman Lockyer were jointly occupied. This naturally turned Pedler's attention to the fascinating problems connected with the physical constitution of the sun and the stars. Consequently, on receiving, in 1873, the appointment as professor of chemistry in the Presidency College, Calcutta, it is not surprising to find that it was some years before he again gave special attention to ordinary terrestrial chemistry. The experience already gained qualified him for observation of meteorological phenomena, and soon after his arrival in India he was charged with special duty in connection with the eclipse expedition in 1875.

At this time, having been born in 1849, Pedler was still a very young man, and before quitting this portion of his career those who knew him in those early days will gladly recall the charming features of his character which made him not only popular in youth, but, remaining unchanged to his latest years, contributed so materially to his success in official life. Chemists who attend the long-established Chemical Dining Club are probably not all aware that it was started by Pedler in or about 1872, and that he acted as secretary so long as he remained in England.

In India, Pedler retained the professorship in Calcutta together with the office of Meteorological Reporter to the Government of Bengal for twenty-two years. He then became principal of the college and vice-chancellor of the Calcutta University. In 1899, he was appointed Minister of Public Instruction in Bengal and additional member of the Legislative Council. These successive steps in official life serve as sufficient explanation of the fact that Pedler's original contributions to scientific chemical literature were limited to the one paper on valeric acids, already mentioned, and several which naturally arose out of the conditions of his occupation in India. Soon after his arrival in that country he examined the coal-gas and the water supplies of Calcutta. In 1878 he sent home a paper on the cobra poison, which was printed in the Proceedings of the Royal Society (vol. xxvii., p. 17); while, in 1890, he contributed to the Journal of the Chemical Society three papers the titles of which show that he was utilising opportunities, previously neglected by chemists, of studying the action of tropical sunlight on chemical change.

On his retirement, Pedler received the honour of knighthood, and on his return to England, in 1906, he speedily found occupation in public work. He became honorary secretary to the British Science Guild, which owes much to his devoted service; and on the outbreak of war he took up active duties connected with the research department of the Ministry of Munitions.

Pedler was twice married, but left no children. His widow was the youngest daughter of the late Mr. Warburton, R.N., of Dedham.

W. A. T.

NOTES.

THE *Financier and Bullionist* of May 14 contains an important article by Sir William Tilden under the title "The Present Position of the Dye Question." The article is addressed mainly to business men, and is, therefore, pretty free from chemical technicalities. It sets forth clearly the causes—partly commercial, partly educational—which led to the decline of the British manufacture and the ascendancy and ultimate practical monopoly of the industry by Germany. The most serious weapon in the hand of the enemy, it is pointed out, is the position of respect which in Germany is accorded to science. The close relation of the universities to the industries of the country, and the fact that the German dye-makers have at their disposal a large body of trained experts, many of them distinguished chemists, who are not only employed in the works, but are also on the directorate, are the chief conditions of the success Germany has achieved in this direction. Sir Albert Stanley, President of the Board of Trade, announced in the House of Commons on May 15 the course which the Board, on behalf of the Government, proposes to take, among other things, in respect to the dye industry. The proposals include further financial aid to manufacturers of special colours and protection for a period of ten years after the war by controlling the importation of foreign dyestuffs by a system of licences. He also stated that negotiations were in progress for the amalgamation of British Dyes, Ltd., and Messrs. Levinstein, Ltd., who were the most important of the dye manufacturers in this country. The arrangements proposed provided for the new company being permanently under British control, for Government representation on the board of directors, and for securing reasonable prices and equitable distribution of the products to the dye-users, so as to avoid anything in the nature of a monopoly. This is all good so far as it goes, but the Government, any more than the man in the street, has not yet grasped the idea that this is a chemical business in the first place, and that to leave the direction chiefly in the hands of Government officials while the chemist is relegated to a subordinate position is to neglect the conditions which have been proved by long experience in Germany to be the only assurance of permanent security and success.

ATTENTION is directed in the *Times Engineering Supplement* for May to the part which technical production is taking in Germany in advancing the fertiliser problem, especially with regard to fertilisers capable of production from synthetic ammonia. For the manufacture of cheap hydrogen, a most essential factor in successful commercial ammonia synthesis, the Badische Anilin- & Soda-Fabrik has developed a catalytic hydrogen process in which large quantities of carbon dioxide are simultaneously obtained. The titles of a series of patents applied for by this company reveal the ideas whereby this by-product is to be utilised. A patent dated August 7, 1914, is concerned with "fertiliser." Three patents in December of the same year cover the manufacture of urea and of products and compounds for use in such manufacture. In June, 1915, a patent application for the manufacture of carbonic acid compounds of ammonia was filed; whilst in March, 1916, a further patent of the same company for fertiliser and method of fertilising was indicated. Obviously the object aimed at is the utilisation of the available carbonic acid from the hydrogen process in preference to the more expensive sulphuric acid necessary for the production of ammonium sulphate. The manufacture of urea would yield a fertiliser containing 43·7 per

cent. of combined nitrogen as compared with 21·2 per cent. in sulphate of ammonia. This tendency in German fertiliser production merits especial consideration by those responsible for the erection of a Haber plant in this country, as indicated in the recent communication of Mr. Kellaway to the House of Commons, since, as a post-war proposition, such a plant would be employed for the manufacture of agricultural fertilisers. By close co-operation between those concerned in the production of hydrogen for synthetic ammonia and the experts in fertiliser values a decision should readily be reached as to the efficacy of carbonaceous ammonia compounds and derivatives, and consequently as to the best course of procedure in regard to hydrogen production.

IN *La Nature* of May 4 Prof. L. de Launay publishes an authoritative article upon the economic importance of Alsace-Lorraine. As might be well supposed from its authorship, the article deals particularly with the mineral products, but refers also to the well-developed textile industries and the various forms of agricultural produce of this region. The author shows that in 1913 German Lorraine produced 21 million tons of iron ore out of a total production of 27·5 millions for Germany (including 6·5 million tons from Luxemburg), whilst French Lorraine produced 19·5 million tons out of a total of 21·7 millions from the whole of France, or a total of 47 million tons of iron ore produced by the whole Lorraine basin. He points out that the possession of this Lorraine iron-ore deposit was the basis not only of Germany's industrial strength, but also of her military power; it is only owing to the possession of this supply of iron ore that Germany has been able to continue the struggle for the last four years. Once, however, Lorraine becomes again a French possession, Germany will be unable to maintain in their present extension the works that produce her engines of destruction, and thus a result would be obtained which otherwise no league of nations, no international tribunal, no treaty capable of being torn up as occasion might require, could secure. Restitution of the Lorraine iron ore to its rightful French owners means, in fact, a guarantee of peace to the world. Of great importance, too, to France would be the Sarre coalfield, which belonged wholly to France up to 1815. When France re-enters into possession of this field, it will be able to supply a certain portion of her needs for coal, having an output of some 17 million tons of coal yearly. Another most valuable mineral product is to be found in the potash deposits of Mulhouse, discovered in 1904, but only slowly developed; the first pit was completed in 1911, in which year the output was 127,000 tons. It must be remembered, however, that Prussia, the owner of the Stassfurt potash deposits, was by no means anxious to see the Alsatian potash deposits developed in competition with the former, and that the Mulhouse deposits can produce very much more than they have done hitherto. Finally, there is a small oilfield just to the north-west of Strasburg, first discovered in 1880, and though far inferior in value to the iron, coal, and potash deposits, nevertheless, with its production of 50,000 tons of oil yearly, it is by no means devoid of importance for France.

THE concluding Friday evening discourses at the Royal Institution are as follows:—On May 24, Lt.-Col. A. G. Hadcock on "Internal Ballistics"; on May 31, Mr. Laurence Binyon on "Poetry and Modern Life"; and on June 7, Sir Boverton Redwood on "The Romance of Petroleum."

THE Duke of Northumberland, who died on May 14 at seventy-two years of age, was a familiar figure in the scientific world. He became a fellow of the Royal Society in 1900 under the rule which permits of the special election of Privy Councillors and men distinguished in the scientific or educational service of the State; and he had been for many years president of the Royal Institution. He was president of the Royal Archæological Institute from 1884 to 1892, and was elected a trustee of the British Museum in 1900.

CAPT. ROALD AMUNDSEN'S long-delayed North Polar Expedition is now announced to start from Norway next month. The *Maud*, the new vessel built for the expedition, is lying ready at Christiania. According to *La Géographie* (vol. xxxii., No. 1), the *Maud* is built on the lines of the *Fram*, and is a three-masted schooner furnished with a petrol motor and capable of a speed of nine knots. Her length is 120 ft., her beam measurement 40 ft., and her draught 12 ft. The screw can be raised to avoid ice-pressure. The petrol capacity of the vessel is 100 metric tons. The original plan of Capt. Amundsen was to enter the Arctic Ocean by Bering Strait. He now proposes to follow the route of the *Fram* through the Barents and Kara Seas along the coast of Asia, and to enter the polar pack about 250 miles east of the New Siberia Islands, allowing his vessel to be caught in the current which crosses the Arctic Ocean.

IN *La Nature* for May 11 Lieut. Lefranc, of the French Air Service, gives very complete particulars of the armament and bomb-dropping arrangements of the modern types of German aeroplane. The armament comprises one or more machine-guns, generally mounted on turrets for securing motion in every direction, some firing through the propeller and synchronised by the aeroplane engine. Standard types of bombs are 22 lb., ½ cwt., 1 cwt., 2 cwt., and 6 cwt., charged with high explosive (T.N.T. and hexanitrodiphenylamine). The ratio of charge is very high. A special type of fuse is fitted in order to secure instantaneous or to delay action. Special frames (vertical or horizontal) are fitted for dropping the bombs, which are discharged in a direction tangential to their trajectory. An adapted Goerz sighting telescope in conjunction with a range-table and a direction or route corrector is employed for securing accuracy. Most bombs are fitted with stabilising vanes at their base in order to ensure the bombs falling nose-on, and to give them a certain amount of spin.

AT the annual meeting of the Illuminating Engineering Society on May 14 the report of the council for the past session was presented. The society has been in communication with the authorities on various subjects, including economy in lighting with a view to fuel-saving, lighting arrangements for air-raid shelters, and the preparation of fuller statistics on the relation between illumination and street accidents. Two committees are carrying on researches for the authorities on parachute flares and luminous gun-sights. It is proposed to form a joint committee with the Ophthalmological Society, to which matters of mutual interest, comprising the effect of illumination on eyesight, can be referred. Following the conclusion of formal business, a discussion on the Lighting, Heating, and Power Order (1918) took place. Mr. L. Gaster, in opening the discussion, said that the society is anxious to assist the authorities to achieve the objects of the Order by preventing waste of light, but it is not desirable to diminish illumination to a value prejudicial to health or eyesight, liable to cause accidents, and interfering with efficiency of work. The maximum saving in fuel possible by the complete carrying out of the Order as regards lighting is small—probably within ½ per cent. of the normal total home coal consump-

tion—but the psychological effect of extravagance in lighting must be considered. A series of recommendations on economy in lighting, prepared by the society with the concurrence of the Board of Trade, was presented. These explain the best methods of economising, importance being attached to avoidance of worn-out and inefficient lamps and burners and their use only when actually required, and to frequent cleansing of lamps and accessories liable to collect dust. In an appendix the essentials of good industrial lighting are stated, and some figures given for the illumination and consumption of gas or electricity considered desirable for various classes of work.

AN interesting address was delivered recently by Sir Robert Hadfield as president of the Society of British Gas Industries, ranging over a number of matters of current interest, such as the economy of fuel, particularly coal and coal-gas, the recent development of the metallurgical industry, scientific and technical education, trade and patent legislation. Sir Robert Hadfield lays much stress upon the very important present-day problem: how to bring about closer co-operation and greater working facilities amongst the numerous technical societies of the country. He points out that some even of our largest and most important societies have no homes of their own, but are, for the most part, housed in offices quite inadequate to the requirements of such important organisations. He quotes as an example the Iron and Steel Institute, representing an industry the annual value of the output of which is not less than two hundred millions sterling, which has offices in Victoria Street, Westminster, with its library placed in one or two small and inconvenient rooms, and contrasts this with the splendid library and spacious accommodation of the corresponding German institution. He urges wisely the need in this country for a central building in which all these technical societies would find a permanent home, with a common library, on similar lines to the Engineering Societies Building of New York, which he characterises as "the chief centre of the great and small technical societies of the great Republic." In addition to containing a fine technical library of more than 150,000 books, as well as the various offices and committee-rooms for twenty-four different societies, this building is closely connected with that of the Engineers' Club, where representatives of all branches of industry are able to meet each other; and Sir Robert Hadfield points out the real value to the technical man of such a common meeting ground.

IN the May issue of *Man* Sir C. H. Read discusses an article by Mr. More Adey in the March issue of the *Burlington Magazine* on "The Registration of Works of Art in Occupied Countries." How the Germans have dealt with the art treasures of the areas occupied by them is well known. The suggestion is that officers and men in Palestine, Mesopotamia, and the less explored frontiers of Egypt should register and preserve objects of art. Sir C. H. Read remarks that a large proportion of both officers and men of our forces now in Africa would welcome so intelligent a diversion from the routine of field or camp life. "The only danger that I foresee is lest some disciplinarian in a high place should promptly condemn the scheme as non-military and a waste of time." He suggests, to avoid this, that an order should be obtained from the War Office commending it as a means of putting the leisure of our soldiers to an intelligent use.

DR. W. L. HILDBURGH describes some Japanese charms connected with earthquakes in the April issue of *Man*. When an earthquake occurs a person in danger should repeat, over and over again, as rapidly as possible, the word *Manzairaku*, signifying "Ten thousand years of happiness." The term is used between persons as a form of congratulation; either on account of its congratulatory significance, or by some play of words, its use during an earthquake is intelligible. The Japanese, for some obscure reason, believe that a privy is the safest place of refuge during an earthquake. This may be due to the fact that the place is a haunt of spirits, and on leaving, one should throw there a piece of iron, like a nail, as a protection. On the whole, Dr. Hildburgh is disposed to connect the belief regarding the privy as analogous to the well-known principle of dressing children in dirty clothes as a charm against the Evil Eye or similar dangers.

BULLETIN No. 172 of the Agricultural Experiment Station of the Rhode Island State College contains the results of a study of infections of fowls by Messrs. P. Hadley and D. J. Lambert and Misses Dorothy Caldwell and Marguerite Elkins. It is established that *Bacterium pullorum* is the causative agent in an epidemic in adult fowls indistinguishable in its manifestations from fowl typhoid, which is caused by *B. gallinarum*. The two organisms may be distinguished by their fermentation reactions. The *B. pullorum* is present in 32 per cent. of the eggs of affected birds.

THE contention that isolation plays an important part in the evolution of species has long been accepted as a trustworthy working hypothesis, and during recent years an impressive array of evidence has been accumulated to justify this interpretation. The latest contribution to this subject has been made by Dr. Hart Merriam in a review of the grizzly and big brown bears of North America (Bureau of Biological Survey, Washington, North American Fauna, No. 41). In a review of this group twelve years ago the author recognised eight species of grizzly and brown bears. He has now increased this to eighty-six. This number, he remarks, "will appear to many preposterous"—unless they have the material before them which he has amassed. From the fine collection of skins and skulls which Dr. Merriam has brought together he has been enabled to show that no sharp dividing line can now be drawn between the grizzly and brown bears. Another surprising result is the discovery that Admiralty Island, off South-east Alaska, appears to be inhabited by no fewer than five distinct species of big bears, each of which is, apparently, related to, and representative of, an adjacent mainland species. In the matter of sexual differences Dr. Merriam is able to show that while the males commonly much exceed the females in the matter of size, in some species there is but little difference. A number of excellent photographs of skulls in profile accompany this paper, but, as the author remarks, they need to be supplemented by views showing the *Norma verticalis*, which furnishes some of the most important characters. Dr. Merriam's work will be read with the deepest interest not only by systematists, but also by those who are interested in the wider problems concerning the evolution of species.

BULLETIN No. 70 of the Agricultural Research Institute, Pusa, is an extremely useful summary by Mr. J. N. Sen, officiating Imperial agricultural chemist, of the composition of a great variety of feeding stuffs available in India, of which samples have been analysed in the laboratory of the Imperial agricultural chemist. The composition of each sample is set out in detail, so that the range of variation can be readily deduced. In addition to the ordinary analytical data, the albuminoid ratio and food units for each sample are given. The tables are prefaced by a brief introduction dealing

with the general characteristics of food ingredients, digestibility, albuminoid ratios, food units, feeding standards, and the computing of rations. The bulletin gives the most comprehensive series of data available, and as such must be regarded as a valuable contribution to Indian agricultural reference literature.

THE Advisory Council of Science and Industry of the Commonwealth of Australia has issued a pamphlet (Bulletin No. 5) dealing with some problems of wheat storage. The bulletin is divided into two parts dealing respectively with damaged grain and insect pests. The former consists of the report of a committee appointed to investigate the utility of quicklime for the preservation of wheat, in accordance with a scheme outlined by Mr. A. O. Barrett. After careful investigation the committee recommends that the process shall be given a trial. Its experiments and observations indicate that ordinary wheat is improved by the treatment, the deterioration of damaged wheat is checked, and any mousy taint is removed. The growth of weevils was not inhibited, nor were their eggs and the young pupæ prevented from developing. The latter problem is dealt with more fully in the second part of the bulletin, which includes a summary of reports received from the Government entomologists of the various States as to insects damaging grain, and a progress report of the special committee on the damage to stored grain by insects. The committee recommends the appointment of a qualified investigator for systematic research on the life-history of the weevils in Australia and the best means of dealing with them, and this proposal is at present under consideration by the Wheat Board.

THE Weather Bureau of the United States Department of Agriculture has in active preparation an "Atlas of American Agriculture," for which the maps dealing with rainfall are practically finished. A copy of the map showing the mean annual rainfall of the United States was issued with the *Monthly Weather Review*, July, 1917, and has since been issued in a separate pamphlet. The map indicates in a marked degree the effect of the western mountains upon the distribution of the precipitation, and, in a less clear fashion, the similar effect of the eastern highlands, while it emphasises the run of the isohyets almost due north from the shores of the Gulf of Mexico between Galveston and the Rio Grande. In the accompanying text Prof. R. DeC. Ward discusses, among other topics, the climatic provinces of the United States. He divides the eastern half of the country into two provinces, Eastern and Gulf, and draws the boundary between them for the western third of its course at right angles to the north and south trend of the isohyets, so that the western third of the Gulf Province has an annual precipitation varying from 20 to 50 in. The Eastern Province contains examples of at least three types of rainfall: the summer rains of the north-west of the province, the coastal rains of the Atlantic lowlands, and an area of continuous rainfall at all seasons near the southern end of the eastern highlands; these subdivisions are ignored.

PROF. S. W. WILLISTON and his pupils continue to make important additions to our knowledge of American Permian Reptilia and Amphibia in the Contributions from Walker Museum (vol. ii., Nos. 1–3), published by the University of Chicago. Many of the fossils are, unfortunately, so badly preserved that there is scope for much difference of opinion as to their interpretation, but the skeleton in several genera is now becoming fairly well known. Some unusually good specimens of the strange Stegocephalian Diplocaulus have just been studied by Mr. Herman Douthitt, who shows that this animal must have been shaped and lived like a skate. Since Cope originally described its very short and broad triangular skull, there has been much speculation as to its nature, and Mr. Douthitt seems to have solved the problem. Some nearly complete skeletons of the primitive reptile Labidosaurus are discussed by Prof. Williston himself, who notes the absence of a neck and the unusual strength of the feet. There are large hook-like incisor teeth in front of the upper jaw, which might assist the feet in grubbing up worms and larvæ. Prof. Williston's studies have led him to make another effort to attain a natural classification of the reptiles. He recognises four main divisions or subclasses, all beginning in Palæozoic times, and all represented by their direct descendants to-day. The Diapsida end in the tuatera, crocodiles, and birds, the Synapsida in mammals, the Parapsida in lizards and snakes, and the Anapsida in tortoises and turtles.

UNDER the title "Physics of the Air," Prof. W. J. Humphries, of the United States Weather Bureau, has been contributing to the Journal of the Franklin Institute since August last a series of articles on the physics of meteorological phenomena. The March issue of the Journal, *e.g.*, contains a description of the seasonal and daily changes of barometric pressure and a discussion of their causes, and the thirteen pages form chap. xi. of the series. Together they constitute a notable addition to the literature of meteorology, and it is to be hoped that the articles will be reissued in book form, so as to be accessible to the large number of readers interested in the fundamental facts of meteorology. For such readers there has, up to the present, been no trustworthy English text-book which discussed the subject from so scientific a viewpoint or dealt with its modern developments so completely.

THE *Photographic Journal* for April contains a description of the photometer for measuring the densities of photographic negatives shown at the March meeting of the Royal Photographic Society by its inventors, Messrs. Benson, Ferguson, and Renwick. The negative is placed on an opal half an inch in diameter, the top surface of which is level with that of a small table in which the opal is inserted. Light from a 15-candle-power headlight lamp placed under the table passes through the opal and negative. Light from the same lamp falls on movable mirrors, by means of which it is thrown on to the under-surface of a second opal near the first, and the distance of the mirrors from the lamp is adjusted until the two opals have the same intensity as determined by a Lummer-Brodhun cube above the table. In describing the instrument at the meeting, Mr. Renwick pointed out that the time had arrived when eye-estimates of densities were no longer sufficiently accurate to enable progress to be made in ascertaining the conditions which determine the density of a negative. In a paper which precedes the description of the photometer in the *Journal*, he shows that the optical properties of the silver grains must be taken into account before photographic densities can be explained satisfactorily.

THE "natural" or spontaneous coagulation of the latex in the production of rubber has been attributed, on one hand to enzyme action, and on the other to the agency of bacteria. Mr. M. Barrowcliff, in the Journal of the Society of Chemical Industry for February 15, adduces good evidence in support of the former theory. Coagulation of latex was found to take place in normal time after addition of toluol, which acts as a bactericide, but is non-toxic to enzymes. Similarly, the addition of thymol did not inhibit or retard coagulation. Small quantities of soluble calcium salts greatly accelerated the action, as

is usual with enzymes; but hydrocyanic acid, which is fatal to nearly all enzymes, completely prevented coagulation. Even the "acid" process of coagulation is considered to be enzymic, the added acid functioning as an enzyme activator.

AT the present time there is only one calcium carbide factory in Great Britain; it is situated in Manchester, and is just now being enlarged to meet war requirements. There are also two small factories in Ireland, the electric current for which is supplied by water-power; but the supply of water is small and erratic, and the output of calcium carbide is only about 1 per cent. of our normal consumption. Mr. C. Bingham (Journal of the Society of Chemical Industry, March 15) gives reasons for the conclusion that in peace times we shall be quite unable to compete with water-power countries like Norway in the production of calcium carbide, unless very much more economical methods than the present ones can be found for producing electricity. From an experimental study of the question he believes this can be done by utilising waste gases from blast-furnaces and coke-ovens as the source of power for generating the current required.

IN the Journal of the Society of Chemical Industry for January 31 Dr. T. Rettie gives an account of work done on antiseptics for the Medical Research Committee at the Pathological Department, Edinburgh University. An urgent requirement of the medical service at the war front was a trustworthy antiseptic for the treatment of heavily infected wounds, with special reference to spore-bearing organisms. The object, therefore, was to find an antiseptic agent thoroughly efficient as a killer of bacteria and spores, and at the same time harmless in its effect on the wound-tissues. Of the various substances tested the hypochlorites were found to be the most efficient germicides. Pure solution of bleaching powder, however, and also sodium hypochlorite solution, are drastic remedies, and on account of their strong alkalinity and high chlorine content they are unsuitable for continued application to wounds. On the other hand, aqueous solutions of hypochlorous acid itself are also unsuited for wound treatment, by reason of the fact that free chloric and hydrochloric acids develop in them through spontaneous reaction. These defects were largely overcome by using a mixture of equal weights of boric acid and bleaching powder ("Eupad"—a name derived from the initial letters of Edinburgh University Pathological Department). An aqueous solution of this ("Eusol") is prepared, of strength 25 grm. per litre; it contains about 0·26 per cent. of hypochlorous acid, together with calcium biborate. In this way the alkalinity of the bleaching powder is reduced, the full effect of the hypochlorous acid secured, and the solution cannot become unduly acid, as the dissociation constant for boric acid has a very low value. Hence the solution can be applied freely to the body tissues, and a large quantity can even be injected into the circulatory system without harmful effect. This solution has been used successfully both for the treatment of wounds and, by intravenous injection, in certain types of gas-gangrene toxæmia.

THE announcements of Messrs. *Longmans and Co.* include "Elements of the Electromagnetic Theory of Light," by Dr. L. Silberstein, and (in the series of Text-books of Physical Chemistry) a new edition of Prof. S. Young's "Stoichiometry," containing rewritten chapters dealing with the more recent determinations of the atomic weights of silver, nitrogen, chlorine, and lead. Messrs. *G. Routledge and Sons, Ltd.*, are to publish "Wealth from Waste: Elimination of Waste a World Problem," by Prof. H. J. Spooner, with a foreword by Lord Leverhulme. Messrs. Routledge also announce "Incidents in the Life of a Mining Engineer," by E. T. McCarthy. Messrs. *Constable and Co., Ltd.*, will shortly publish "The Future Citizen and his Mother," by Dr. C. Porter, with a foreword by Sir J. Crichton Browne. Messrs. *Henry Frowde and Hodder and Stoughton* have in the press "Vaccines and Sera," by Capt. A. G. Shera, and "The Hearts of Man," by R. McNair Wilson.

OUR ASTRONOMICAL COLUMN.

MINOR PLANETS.—The following ephemerides of Pallas and Ceres are from the Rechen-Institut's List:—

Pallas: Magnitude 8·8.

Date	R.A. h. m.	N. Decl. ° ′	Log r	Log Δ
May 26	17 9·4	25 19	0·489	
June 3	17 2·6	25 46		0·368
11	16 55·7	25 53		0·372
19	16 49·2	25 39		0·379
27	16 43·4	25 6		0·388
July 5	16 38·6	24 17	0·500	

Ceres: Magnitude 7·6.

Date	R.A. h. m.	S. Decl. ° ′	Log r	Log Δ
June 11	18 23·9	25 57	0·457	
19	18 16·4	26 29		0·269
27	18 8·6	26 58		0·270
July 5	18 0·9	27 23		0·274
13	17 54·0	27 44		0·283
21	17 48·2	28 1	0·461	

Planet 31 Euphrosyne was observed on April 13 and 14; the ephemeris needs the large corrections −12·4m.+ 3° 12′. The interesting planet DB, discovered by Wolf on January 3, has been named Alinda.

CURRENTS IN THE UPPER AIR.—The behaviour of the streaks or trains left by large meteors supplies abundant evidence as to the rapid motion of the atmosphere at its outer limits. The diversity of direction, as well as the rate of velocity, of these upper winds is remarkable; in fact, hurricane speed would appear to be quite a common feature amongst them. It is true that the data are not of sufficiently accurate character to allow very exact deductions to be drawn, but there is no doubt as to the general correctness of the results. In some instances the observations have been as complete as they have been precise, and these corroborate in a very satisfactory manner the average values obtained from more uncertain or incomplete records.

The long-enduring streaks of swift fireballs, like the Perseids and Leonids, are usually about fifty-five or sixty miles in height, but they may extend from heights of fifty to seventy miles. The mean velocity of their drift is 121 miles per hour, and the predominating direction to the eastward, but there is no quarter to which these lofty cosmic clouds may not be carried. Of seventy-eight enduring meteoric streaks motion was found to be directed to points at or between north-east and south-east in thirty-seven cases, while to the points north-west to south-west there were only twenty-four. The individual velocities varied from nil to 360 miles per second. In some cases a moderate speed of twenty-seven or thirty miles per hour was indicated. Certain streaks gave evidence of a series of differing currents underlying each other, the upper sections drifting in different directions to the lower.

DISTANCE OF THE ORION NEBULA.—An interesting estimate of the distance of the Orion nebula has been made by Prof. W. H. Pickering (Harvard Circular No. 205). From a consideration of the brightnesses and distribution of the stars in the nebula and in the surrounding region, it is concluded that practically all the stars within the nebula are of type B, and that there are no stars in the nebula fainter than fifteenth magnitude. Since we are looking very nearly along the axis of the great spiral nebula which stretches over nearly the whole length of Orion, and is connected with the great nebula, all the stars associated with it must be at approximately the same distance from us. Russell has shown that only very massive stars can attain the colour of type B; and assuming 10·5 as the mean magnitude of the stars within the nebula, while the average absolute magnitude of such stars may be taken as −1·0, it follows that the distance of the nebula is 6520 light-years, or that the parallax is 0·0005″. Among the interesting results which follow, the mean diameter of the brilliant Huygenian region is found to be 6·3 light-years, and the distance between the extreme stars of the trapezium 0·68 light-year. It is also calculated that Rigel is 2,100,000 times as bright as the sun, thus far exceeding Canopus, for which Walkey estimated a brightness of 50,000 times that of the sun.

TERRESTRIAL MAGNETIC OSCILLATIONS.

THE paper referred to below[1] is an important contribution to our knowledge of oscillations in the magnetic elements, especially those of shorter period termed "pulsations" by van Bemmelen. The records were obtained in an underground chamber near the Marine Biological Laboratory at Misaki, between 1910 and April, 1914, with a special set of very sensitive magnetographs, designed by Prof. Tanakadate. The magnetographs, which recorded the north (N), west (W), and vertical (V) components, show several original features. The V instrument, which worked very satisfactorily, had the magnet carried by horizontal quartz fibres. The sensitiveness of the instruments was about 0·15 γ per 1 mm., and the time-scale about 3½ mm. to the minute.

The original object was to ascertain whether seismic movements were accompanied by magnetic waves. No certain connection was established, but many interesting records of pulsations were obtained. The distribution of pulsations throughout the twenty-four hours varied markedly with the period, waves with periods less than seventy seconds having their maximum frequency during the day, and those with periods longer than ninety seconds having their maximum during the night. Periods shorter than thirty seconds were rare. Pulsations in V were almost facsimiles of those in N, except that they were of smaller amplitude and had a retardation of phase. As the period became longer, the ratio borne by the amplitude of the V to that of the N pulsation increased, while the difference in phase diminished. The hour of the day seemed without direct influence on the value of the ratio. The relation between the pulsations in N and W, on the other hand, depended largely on the hour of the day. Regarding north and west as the positive directions in the two cases, it was found that agreement in phase between N and W pulsations was most frequent in the early morning, whilst direct opposition in phase was most frequent in the evening. Cases in which the N pulsation was largely dominant were most frequent near noon and near midnight.

Generally there was a marked tendency in the vector in the horizontal plane to rotate, after the fashion first described by R. B. Sangster for longer-period movements. According to the author, in pulsations at Misaki, clock-wise rotation is most frequent between sunrise and noon, and again between sunset and midnight, anti-clock-wise rotation predominating in the intermediate hours. One interesting feature, which the author thinks may possess considerable significance, is a tendency when pulsations start abruptly for N to show a rapid rise. He is disposed to attribute pulsations to fluctuations in the electrical currents in the upper atmosphere, to which the regular diurnal magnetic variation is now generally ascribed. If, as he thinks most likely, pulsations arise simultaneously and not successively at different stations, the currents in the upper atmosphere probably fluctuate in intensity as well as in position. This might, he thinks, arise from vertical oscillations in limited portions of the upper atmosphere. A variety of mathematical problems relating to oscillating linear electric currents are worked out. The plates at the end contain numerous interesting examples of pulsations.

C. CHREE.

[1] "On Rapid Periodic Variations of Terrestrial Magnetism." By Torahiko Terada. Journal of the College of Science, Imperial University of Tokyo, vol. xxxvii., 1917, Art. 9. Pp. 85+5 plates.

GLOBULAR STAR CLUSTERS.

MR. HARLOW SHAPLEY'S preliminary work on the distances of the globular clusters attracted much attention two years ago. He has since then diligently pursued the subject, and gives an interesting summary of the progress of his researches in Pubns. Astr. Soc. Pac., February, 1918.

His methods are :—(1) To determine the photographic and photo-visual magnitudes of the cluster stars by photographs on ordinary and panchromatic plates. The colour-indices of the stars are thus determined and their spectral types inferred. The fact that stars are found in the clusters quite as blue as the B stars in our neighbourhood leads to the assumption that light absorption is negligible. The distances can then be inferred, making assumptions on the absolute magnitudes of stars of different spectral types.

(2) The work of Miss Leavitt, Hertzsprung, and Shapley shows that the absolute magnitude of Cepheid variables is a function of the period of light variation. A curve is given in the article, from which the following values have been measured :—

Period (days)	Abs. mag.	Period (days)	Abs. mag.
63	−6	4·9	−2
33	−5	1·7	−1
17	−4	0·85	−0·5
9·2	−3	0·7 (and under)	−0·3

Since the cluster variables conform mainly to the Cepheid type, this affords a very accurate means of obtaining the distances of clusters. Mr. Shapley notes that the long-period Cepheids are the most luminous of all stars. The longest observed period is about 130 days, absolute magnitude −6·8 (indicating about 50,000 times the luminosity of the sun). Cepheid variables are also notable for their rapid motion, which appears to average more than 100 km./sec.

(3) By the above methods the average absolute magnitude (photographic) of the brighter stars of the different clusters (twenty-five stars selected from each cluster, rejecting the five brightest) is found to be −1·5. Making this assumption for other clusters, we can estimate their distance without waiting for more detailed researches.

(4) There is found to be a fairly close correlation between distance and apparent diameter, indicating that the linear diameter of a cluster is a function of its distance. With diameter 1·4′ corresponds distance

130,000 light-years; 3·9′, 65,000 L.Y.; 7·7′, 43,000 L.Y.; 12·4′, 33,000 L.Y.; 20′, 26,000 L.Y.

These methods have been applied to finding the distances of sixty-nine globular clusters. The nearest are ω Centauri and 47 Tucanæ, 23,000 L.Y.; the average distance is 75,000 L.Y.; seventeen clusters are more distant than 100,000 L.Y.; the most distant is N.G.C. 7006, some 200,000 L.Y. (more than a trillion miles, using the British system of numeration).

The distribution in galactic longitude is curious. There are none between 45° and 190°, while more than half are between 300° and 350°. In latitude there are maxima on each side of the galaxy, with a gap in the galactic plane itself. The system forms a split ellipsoid with longest diameter some 300,000 L.Y., and distance of centre 65,000 L.Y. The co-ordinates of the centre are R.A. 17h. 30m., S. decl. 30°. While lying outside the galactic limits, the distribution of the clusters indicates that they form part of the same cosmic unit as the galaxy. Some preliminary investigations of their radial velocities by Prof. Slipher indicate that these are high, but smaller than those of the spiral nebulæ. A. C. D. CROMMELIN.

FROST IN THE UNITED STATES.

IN a paper with the above title presented before the second Pan-American Scientific Congress at Washington (Washington: Government Printing Office, 1917) Mr. William Gardner Reed discusses the damage by frost in the United States. Following the rule of the Weather Bureau, he classifies frosts as "light," "heavy," and "killing," but he determines the dates of the last killing frost in spring and the earliest in autumn from the records of temperature, and not from the reports of damage. This is fully justified by the fact that the observations of temperature are continuous and exact, whereas the damage depends on many conditions.

The number of observations at any one individual station is seldom sufficient to show the precise chance of frost after a given date at that particular station, but if the observations at neighbouring stations are utilised, a sort of general mean date for the last frost in a district can be obtained. Working on these lines, Mr. Reed gives maps of the United States with lines showing the limits for killing frosts at various dates, the consecutive lines showing differences of ten days in the date. Thus the date for a line running close to the Gulf of Mexico is March 1, but for a line near the Canadian boundary it is as late as May 21.

The mean date of the last or earliest frost is not of much importance to the cultivator; he wants to know the date beyond which he will be reasonably safe from damage. For this purpose Mr. Reed calculates the standard deviation of the date, and since he finds that the distribution follows the normal curve, he is thus able to give the date beyond which a killing frost is not likely to occur more than once in ten years. This is, no doubt, a much more trustworthy method than using the extreme dates at each separate station. Charts are prepared in a similar way for the first killing frost in autumn; near the Canadian boundary the date is as early as September 1, but delayed until November 1 near the Gulf Coast.

The meteorological conditions that favour frost are not quite the same over the different States, though they are, in general, the clear skies of an anticyclone with their local nocturnal cooling. As a rule, east of the Rocky Mountains the frost area is south-east, and somewhat in advance of the anticyclone. In California north-easterly and easterly winds prevail for twenty-four or thirty-six hours beforehand, and a frost occurs if a clear sky accompanies the dropping of the wind.

Mr. Reed also discusses the cause why plants are damaged by frost, and arrives at the conclusion that the matter is far from being well understood. It is a very common belief that the damage is not so serious if the rise of temperature is slow, but Mr. Reed says that recently accumulated evidence throws some doubt upon this. He appears to hold that the length of time during which the trees are exposed to the cold is of importance, and that even if the heating of an orchard has been delayed until after the critical temperature is reached, there may still be time to save the fruit; and he concludes this part of his subject by saying that "evidently much more investigation is needed concerning the nature of frost effects within the plant."

CONSTRUCTION FOR AN APPROXIMATE QUADRATURE OF THE CIRCLE.

THE issue of the *Comptes rendus* of the Paris Academy of Sciences for March 25 last contains a paper by M. de Pulligny on a simple geometrical representation of the approximations to the numerical value of π given by Archimedes and Metius. Other approximations can be represented in the same way.

The construction is as follows:—Let OA and OB be two radii of a circle at right angles to one another. Let S be the mid-point of OA. Draw through S a line cutting the circle in P and Q, and OB (produced if necessary) in R. Let $OA=a$, $OR=ya$, $PQ=u$. Then we have $u^2=\{4-4y^2/(1+4y^2)\}a^2=$(say) ma^2. As PQ rotates round S, y varies continuously from 0 to ∞, and m from 4 to 3. When $y=0$, the square on PQ is greater than the area of the circle; when $y=\infty$, it is less: thus, in intermediate positions of the chord, the square on PQ gives an approximate quadrature of the circle, and m gives an approximate value of π.

The point R determines the chord PQ. If on AO produced we take a point I so that $4.AI=5a$, and if with I as centre and IA as radius we draw a circle cutting OB produced in R, we have $y^2=3/2$, and $m=22/7$, the higher limit given by Archimedes.

If on AO produced we take a point J so that $8.OJ=a\sqrt{3}$ (a result for which a geometrical construction can be easily given), and if with J as centre and IA as radius we draw a circle cutting OB produced in R, we have $y^2=(6+1/16)/4$, and $m=355/113$, the approximation given by Metius.

It will be noticed that there is nothing in this construction to enable us to fix the limits within which we must choose R to get a close approximation; but corresponding with any assigned value of m, and therefore of y, it gives a geometrical construction for the side of the square thus determined.

W. W. ROUSE BALL.

RADIATION AND THE ELECTRON.[1]

RECENT developments in the domain of radiation are of extraordinary interest and suggestiveness, but they lead into regions in which the physicist sees as yet but dimly—indeed, even more dimly than he thought he saw twenty years ago.

But while the beauty of a problem solved excites the admiration and yields a certain sort of satisfaction, it is, after all, the unsolved problem, the quest of the unknown, the struggle for the unattained, which is of universal and most thrilling interest. I make no

[1] Address to the Section of Physics and Chemistry of the Franklin Institute, Philadelphia, on January 4, 1917, by Prof. R. A. Millikan, professor of physics in the University of Chicago. The substance of this lecture has since been incorporated into a book recently issued by the University of Chicago Press, entitled "The Electron."

apologies, therefore, for presenting to-night one of the great unsolved problems of modern physics, nor for leaving it with but the vaguest of suggestions towards a solution.

The newest of the problems of physics is at the same time the oldest. For nothing is earlier in the experiences either of the child or of the race than the sensation of receiving light and heat from the sun. But how does light get to us from the sun and the stars through the empty interstellar spaces? The Greeks answered this query very simply and very satisfactorily from the point of view of people who were content with plausible explanations, but had not yet learned perpetually to question Nature experimentally as to the validity or invalidity of a conclusion. They said that the sun and all radiators of light and heat must shoot off minute corpuscles the impact of which upon the eye or skin produces the sensations of light and warmth.

This corpuscular theory was the generally accepted one up to A.D. 1800. It was challenged, it is true, about 1680 by the Dutch physicist Huygens, who, starting with the observed phenomena of the transmission of water waves over the surface of a pond or of sound waves through the air, argued that light might be some vibratory disturbance transmitted by some medium which fills all interstellar space. He postulated the existence of such a medium, which was called the luminiferous or light-bearing æther.

Partly no doubt because of Newton's espousal of the corpuscular theory, the æther or wave theory gained few adherents until some facts of interference began to appear about 1800, which baffled explanation from the point of view of the corpuscular theory, but were easily handled by its rival. During the nineteenth century the evidence became stronger and stronger, until by its close the corpuscular theory had been permanently eliminated for four different reasons: (1) The facts of interference were not only found inexplicable in terms of it, but also completely predicted by the wave theory. (2) The fact that the speed of propagation of light was experimentally found to be greater in air than in water was in accord with the demands of the æther theory, but directly contrary to the demands of the corpuscular theory. (3) Wireless waves had appeared and been shown to be just like light waves save for wave-length, and they had been found to pass over continuously, with increasing wave-length, into static electrical fields such as could not possibly be explained from a corpuscular point of view. (4) The speed of light had been shown to be independent of the speed of the source as demanded by the æther theory and denied by the corpuscular theory.

By 1900, then, the æther theory had become apparently impregnably entrenched. A couple of years later it met with some opposition of a rather ill-considered sort, as it seems to me, from a group of extreme advocates of the relativity theory, but this theory is now commonly regarded, I think, as having no bearing whatever upon the question of the existence or non-existence of a luminiferous æther. For such an æther was called into being solely for the sake of furnishing a carrier for electromagnetic waves, and it obviously stands or falls with the existence of such waves *in vacuo*, and this has never been questioned by anyone so far as I am aware.

Up to 1903, then, the theory which looked upon an electromagnetic wave as a disturbance which originated at some point in the æther at which an electric charge was undergoing a change in speed, and was propagated from that point outward as a spherical wave or pulse, the total energy of the disturbance being always spread uniformly over the wave front, had met with no serious question from any source. Indeed, it had been extraordinarily successful, not only in accounting for all the known facts, but also in more than one instance in predicting new ones. The first difficulty appeared after the discovery of the electron and in connection with the relations of the electron to the absorption or emission of such electromagnetic waves. It was first pointed out in 1903 by Sir J. J. Thomson in his Silliman lectures at Yale. It may be stated thus:—

X-rays unquestionably pass over, or by, all but an exceedingly minute fraction, say one in a thousand billion, of the atoms contained in the space traversed without spending any energy upon them or influencing them in any observable way. But here and there they find an atom from which, as is shown directly in C. T. R. Wilson's photographs (Figs. 1 and 2), they hurl a negative electron with enormous speed. This is the most interesting and most significant characteristic of X-rays, and one which distinguishes them from the α and β rays just as sharply as does the property of non-deviability in a magnetic field; for

FIG. 1.—Tracks of β particles ejected by X-rays from molecules of air.

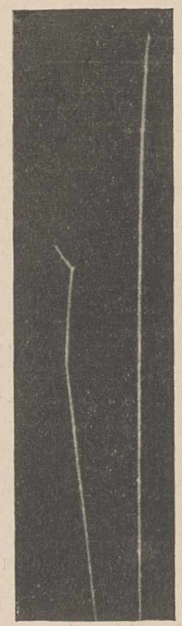

FIG. 2.—Tracks of α rays in air.

neither α nor β rays ever eject electrons from the atoms through which they pass with speeds comparable with those produced by X-rays, else there would be new zigzag lines branching out from points all along the paths of the α and β particles shown in the Wilson photographs.

But this property of X-rays introduces a serious difficulty into the æther theory. For if the electric intensity in the wave front of the X-ray is sufficient thus to hurl a corpuscle with huge energy from one particular atom, why does it not at least detach corpuscles from all the atoms over which it passes?

Again, when ultra-violet light falls on a metal it, too, like X-rays, is found to eject negative electrons. This phenomenon of the emission of corpuscles under the influence of light is called the photo-electric effect. Lenard (*Ann. d. Phys.* [4], vol. viii. [1902], p. 149) first made the astonishing discovery that the energy of ejection of the corpuscle is altogether independent of the intensity of the light which causes the ejection, no matter whether this intensity is varied by varying the distance of the light or by introducing absorbing

screens. I have myself (*Phys. Rev.*, vol. ii. [1913], p. 173) subjected this relation to a very precise test and found it to hold accurately. Furthermore, this sort of independence has also been established for the negative electrons emitted by both X- and γ rays.

Facts of this sort are evidently difficult to account for on any sort of a spreading-wave theory. But it will be seen that they lend themselves to easy interpretation in terms of a corpuscular theory, for if the energy of an escaping electron comes from the absorption of a light-corpuscle, then the energy of emission of the ejected electron ought to be independent of the distance of the source, as it is found to be, and, furthermore, corpuscular rays would hit but a very minute fraction of the atoms contained in the space traversed by them. This would explain, then, both the independence of the energy of emission upon intensity and the smallness of the number of atoms ionised.

In view, however, of the four sets of facts mentioned above, Thomson found it altogether impossible to go back to the old and exploded form of corpuscular theory for an explanation of the new facts as to the emission of electrons under the influence of æther waves. He accordingly attempted to reconcile these troublesome new facts with the wave theory by assuming a fibrous structure in the æther and picturing all electromagnetic energy as travelling along Faraday lines of force conceived of as actual strings extending through all space. Although this concept, which we shall call the æther-string theory, is like the corpuscular theory in that the energy, after it leaves the emitting body, remains localised in space, and, when absorbed, is absorbed as a whole, yet it is after all essentially an æther theory. For in it the speed of propagation is determined by the properties of the medium and has nothing to do with the nature or condition of the source. Thus the last three of the fatal objections to a corpuscular theory are not here encountered. As to the first one, no one has yet shown that Thomson's suggestion is reconcilable with the facts of interference, though, so far as I know, neither has its irreconcilability been as yet absolutely demonstrated.

But interference aside, all is not simple and easy for Thomson's theory. For one encounters serious difficulties when he attempts to visualise the universe as an infinite cobweb the threads of which never become tangled or broken, however swiftly the electrical charges to which they are attached may be flying about.

Yet the boldness and the difficulties of Thomson's "æther-string" theory did not deter Einstein (*Ann. d. Phys.* [4], vol. xvii. [1905], p. 132; vol. xx. [1906], p. 199) in 1905 from making it even more radical. In order to connect up with some results to which Planck, of Berlin, had been led in studying the facts of black-body radiation, Einstein assumed not only that the energy emitted by any radiator kept together in bunches or quanta as it travelled through space, as Thomson had assumed it to do, but also that a given source could emit and absorb radiant energy only in units which are all exactly equal to $h\nu$, ν being the natural frequency of the emitter and h a constant which is the same for all emitters.

I shall not attempt to present the basis for such an assumption, for, as a matter of fact, it had almost none at the time. But whatever its basis, it enabled Einstein to predict at once that the energy of emission of corpuscles under the influence of light would be governed by the equation

$$\tfrac{1}{2}mv^2 = Ve = h\nu - p \qquad (41)$$

in which $h\nu$ is the energy absorbed by the electron from the light wave or light quantum, for according to the assumption that it was the whole energy contained in that quantum, p is the work necessary to get the electron out of the metal, and $\frac{1}{2}mv^2$ is the energy with which it leaves the surface—an energy evidently measured by the product of its charge e by the potential difference V, against which it is just able to drive itself before being brought to rest.

At the time at which it was made this prediction was as bold as the hypothesis which suggested it, for at that time there were available no experiments whatever for determining anything about how the positive potential V necessary to apply to the illuminated electrode to stop the discharge of negative electrons from it under the influence of monochromatic light varied with the frequency ν of the light, or whether the quantity h to which Planck had already assigned a numerical value appeared at all in connection with photo-electric discharge. We are confronted, however, by the astonishing situation that after ten years of work at the Ryerson Laboratory and elsewhere in the discharge of electrons by light this equation of Einstein's seems to us to predict accurately all the facts which have been observed.

The method which has been adopted in the Ryerson Laboratory for testing the correctness of Einstein's

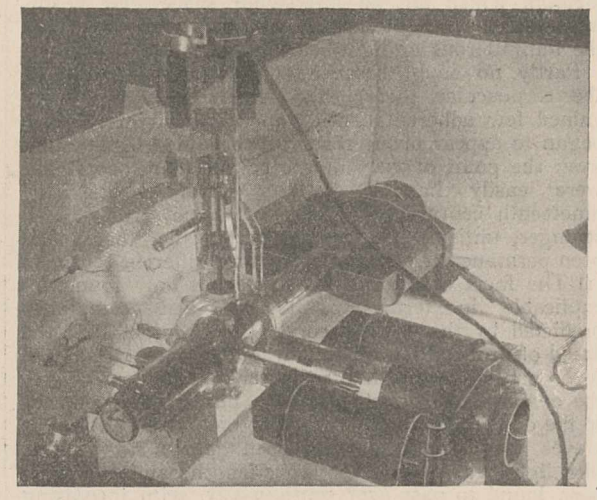

FIG. 3.—Photograph of apparatus used for the photo-electric determinatio of Planck's h.

equation has involved the performance of so many operations upon the highly inflammable alkali metals in a vessel which was freed from the presence of all gases that it is not inappropriate to describe the present experimental arrangement as a machine-shop *in vacuo*. Fig. 3 shows a photograph of the apparatus, and Fig. 4 is a drawing of a section which should make the necessary operations intelligible.

One of the most vital assertions made in Einstein's theory is that the kinetic energy with which monochromatic light ejects electrons from any metal is proportional to the frequency of the light, *i.e.* if violet light is of half the wave-length of red light, then the violet light should throw out the electron with twice the energy imparted to it by the red light. In order to test whether any such linear relation exists between the energy of the escaping electron and the light which throws it out it was necessary to use as wide a range of frequencies as possible. This made it necessary to use the alkali metals, sodium potassium, and lithium, for electrons are thrown from the ordinary metals only by ultra-violet light, while the alkali metals respond

in this way to any waves shorter than those of the red—that is, they respond throughout practically the whole visible spectrum as well as the ultra-violet spectrum. Cast cylinders of these metals were therefore placed

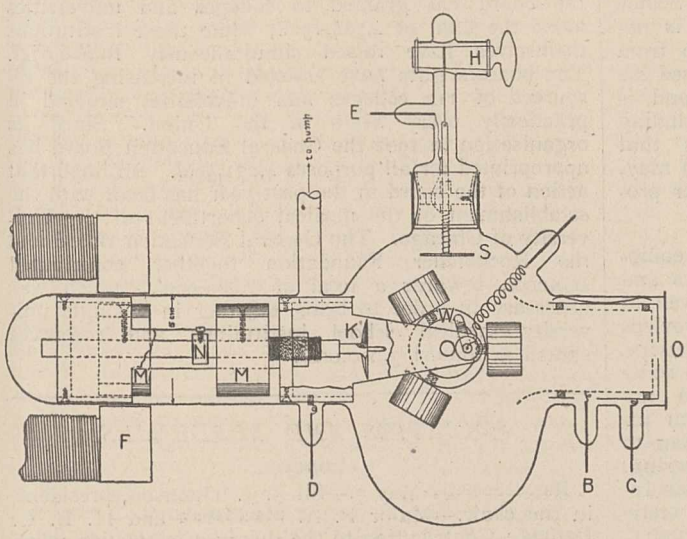

FIG. 4.—Cross-sectional drawing of apparatus of Fig. 3.

on the wheel W (Fig. 4), and fresh, clean surfaces were obtained by cutting shavings from each metal in an excellent vacuum with the aid of the knife K, which was operated by an electromagnet F outside the tube. After this the freshly cut surface was turned around by another electromagnet until it was opposite the point O of Fig. 4, and a beam of monochromatic light from a spectrometer was let in through O and allowed to fall on the new surface. The energy of the electrons ejected by it was measured by applying to the surface a positive potential just strong enough to prevent any of the discharged electrons from reaching the gauze cylinder opposite (shown in dotted lines) and thus communicating an observable negative charge to the quadrant electrometer which was attached to this gauze cylinder. For a complete test of the equation it was necessary also to measure the contact-electromotive force between the new surface and a test plate S. This was done by another electromagnetic device

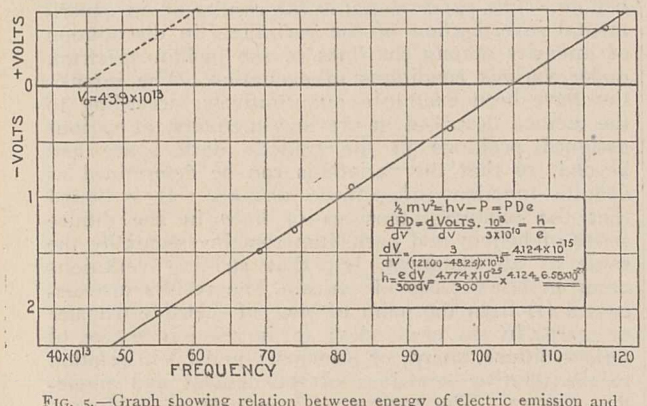

FIG. 5.—Graph showing relation between energy of electric emission and frequency of the light which stimulates the emission.

shown in Fig. 3, but for further details the original paper may be consulted (see *Phys. Rev.*, vol. vii. [1916], p. 362). Suffice it here to say that Einstein's equation demands a linear relation between the applied positive volts and the frequency of the light, and it also demands that the slope of this line should be exactly equal to h/e. Hence from this slope, since e is known, it should be possible to obtain h. How perfect a linear relation is found may be seen from Fig. 5, which also shows that from the slope of this line h is found to be $6{\cdot}56 \times 10^{-27}$, which is as close to the value obtained by Planck from the radiation laws as is to be expected from the accuracy with which the experiments in radiation can be made. The most trustworthy value of h obtained from a consideration of the whole of this work is $h = 6{\cdot}56 \times 10^{-27}$. In the original paper will be found other tests of the Einstein equation, but the net result of all this work is to confirm in a very complete way the equation which Einstein first set up on the basis of his semi-corpuscular theory of radiant energy. And if this equation is of general validity it must certainly be regarded as one of the most fundamental and far-reaching of the equations of physics, and one which is destined to play in the future a scarcely less important *rôle* than Maxwell's equations have played in the past, for it must govern the transformation of all short-wave-length electromagnetic energy into heat energy.

(*To be continued.*)

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

LONDON.—The thanks of the Senate have been accorded to the Worshipful Company of Drapers for the renewal, at the rate of 300*l.* a year for 1918 and 1919, of their grant in aid of the biometric laboratories of the department of applied statistics at University College; and to the Chadwick trustees for the renewal of their grant of 250*l.* in furtherance of the promotion of sanitary science by aiding the maintenance of the Chadwick professorship of hygiene and the teaching of municipal engineering at University College during the year 1918–19, and for their continued provision of the Chadwick gold medal.

The Senate has adopted a resolution expressing gratification that the London Hospital has decided to open its medical college to women students—"a step which is in entire conformity both with the wishes and the policy of the University."

The following doctorates have been conferred:—*D.Sc. in Statistics:* Mr. R. J. Ewart, an internal student, of the Lister Institute of Preventive Medicine, for a thesis entitled "The Influence of Age of Parent at Birth on Length of Life, Sex, Susceptibility to Zymotic Diseases, Stature, Intelligence, and Eye-colour." *D.Sc. in Botany:* Mr. Walter Watson, an external student, for a thesis entitled "The Bryophytes and Lichens of Various Ecological Groups of Vegetation," and other papers. *D.Sc. in Physics:* Mr. E. N. da Costa Andrade, an external student, for a thesis entitled "The Flow of Metals under Constant Stresses," and other papers.

THE remaining public lectures of the course on "Some Biological Problems of To-day" will be delivered at University College, London (Gower Street, W.C.1), on Mondays at 5 p.m., as follows:—May 27, "Substitution of Raw Materials," by Prof. F. W. Oliver; June 3, "The Anaerobic Treatment of Wounds," by Dr. R. C. McLean; and June 10, "Fresh Air and Efficiency," by Prof. H. R. Kenwood.

THE Registrar of the Institute of Chemistry has been informed by the Board of Education that "instructions have been given by the National Service Department to defer, for the present, the calling up of any student of chemistry attending a teaching institution recognised by the Board of Education or the Scotch Education Department who has not been or is not placed in Grade I. and produces a certificate from the principal of the institution that he has passed his matriculation or corresponding examination, and is taking a full course of study in science, including chemistry. The Board further understands that calling-up notices (including any already issued) may, if necessary, be suspended for fourteen days for production of this certificate."

A DETAILED description of the curriculum and equipment of the Institute of Applied Electrotechnics and Mechanics at the University of Toulouse is given in *Le Génie Civil* for April 27. The institute provides a thorough course of training in electrical engineering and applied mechanics, which lasts three (and in some cases four) years. The laboratories, which are equipped in an up-to-date manner, provide both for teaching and research. Special attention is given to hydraulic and internal-combustion engineering. Separate sections are devoted to technical measurements on electrical machines and accessories, static electricity and magnetic measurements, photometry, wireless telegraphy, etc. A special water-tower and auxiliary plant is installed for experiments on water pressure and flow—an innovation that will prove of great value in view of the proposed extension of hydro-electric power in different parts of France.

A DELEGATION of ten distinguished professors from universities of Italy is visiting eight of our universities, namely, Oxford, London (and the Imperial College), Cambridge, Manchester, Leeds, Sheffield, Edinburgh, and Glasgow. The members of the delegation are:—Prof. Volterra, senator, professor of mathematics in the University of Rome; Prof. Archangeli, professor of commercial law in the University of Parma; Prof. L. Bianchi, deputy, professor of psychiatry in the University of Naples; Signor V. Bianchi, deputy, specialist in nervous diseases; Prof. Columba, Rector of the University of Palermo, professor of ancient history; Prof. Credaro, late Minister of Public Instruction, deputy, professor of philosophy in the University of Rome; Prof. Galante, professor of canon law in the University of Bologna; Prof. Giacosa, professor of bio-chemistry and physiology in the University of Turin; Prof. Lori, Rector of the University of Padua, professor of electro-technics, president of the Società per il Progresso delle Scienze; and Prof. Nasini, professor of chemistry in the University of Pisa. Oxford was visited last week, and the visit to London began at University College on Tuesday, when the Vice-Chancellor entertained the delegation at dinner. On Wednesday the Imperial College was visited, and the party lunched with the Lord Mayor at the Mansion House. To-day (Thursday) will be occupied with visits to King's College and Bedford College and a dinner given by the Royal Society of Literature.

THE General Education Board, founded by Mr. John D. Rockefeller "to promote education within the United States," will shortly issue its complete annual report for the financial year 1916–17. The grants for that year included the following:—Universities and colleges for whites, for endowment, 237,000*l.*; colleges and schools for whites for current expenses, 2000*l.*; medical education, 270,000*l.*; the education of negroes, 68,607*l.*; professors of secondary education, 6993*l.*; farm demonstration work in Maine (including boys' and girls' clubs), 4300*l.*; farm demonstration work in New Hampshire (including boys' and girls' clubs), 3000*l.*; educational investigation and research, 10,200*l.*; consolidated rural schools, 2000*l.*; experimental school, 9350*l.*; the total being 628,453*l.* Since its foundation the board has granted to colleges and universities alone the total of 2,724,152*l.*, while those institutions themselves have raised simultaneously 10,026,674*l.* The board's gifts have assisted in increasing the resources of 112 colleges and universities situated in practically every State in the Union. Since its organisation in 1902 the General Education Board has appropriated for all purposes 4,271,500*l.* An important action of the board in the past year has dealt with the establishment of the medical department of the University of Chicago. The General Education Board and the Rockefeller Foundation together contributed 400,000*l.* towards a total of 1,060,000*l.*, which was necessary in order to bring together in a single university medical school institutions and resources valued at almost 3,000,000*l.*

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, May 9.—Sir J. J. Thomson, president, in the chair.—Major P. A. **MacMahon** and H. B. C. **Darling**: Contribution to the theory of attraction when the force varies as any power of the distance.—Sir George **Greenhill**: Electromagnetic integrals. Starting with Maxwell's M, mutual inductance of two coaxial circular currents, a straightforward integration will lead to the analytical expressions arising in the theory of the ampere-balance current-weigher, described in *Phil. Trans.*, 1907, by Ayrton-Mather-Smith, and the complicated dissections are not necessary, employed by Viriamu Jones, Minchin, and other writers. The elliptic integrals which occur are then reduced to a simple standard form, capable of use with Legendre's tables of the elliptic function; and the quadric transformation is explained geometrically, required to reconcile the conflicting notation of previous treatment. A re-drawing is submitted of Maxwell's figure XVIII of the curves of constant M, employing the co-ordinates of the confocal conics on Weir's chart. The same co-ordinates are applied to a state of uniplanar liquid motion, where they appear appropriate, as well as to Euler's problem of the orbit under two centres of force.—Dr. T. R. **Merton** and Prof. J. W. **Nicholson**: Intensity relations in the spectrum of helium. The paper contains the results of an experimental investigation of the variations in distribution of intensity among the lines of the helium spectrum under various conditions of excitation. The intensities have been examined quantitatively, according to the method described in previous memoirs, at various assigned positions in the cathode dark space and beyond, so that the variations can be determined as definite functions of cathode distance. It is found that the relative intensities of lines in the diffuse series of helium and parhelium remain essentially the same at all distances, but that striking variations occur in other types of series. The results are discussed (1) from the point of view of selective transfer of energy in any one series; (2) in relation to type of series—diffuse, sharp, or principal; and (3) in relation to the relative behaviour of the doublet and single-line spectra. The spectra of mixed gases—hydrogen and helium—have also been studied in the same way, and it has become apparent that the phenomena presented by the presence of a spectroscopic trace of one of the gases are essentially different in character from those presented when the gases are mixed in comparable amounts. The low-pressure spectrum of

helium has been investigated quantitatively, and the results have been discussed with special reference to the reproduction in the laboratory of the abnormal intensity relations found in the spectra of the nebulæ. It is shown that the nebular spectrum of helium would be obtained very closely by a combination of the conditions belonging to the condensed discharge and to the low-pressure spectrum.—Dr. S. **Chapman**: The outline of a theory of magnetic storms. The average characteristics of magnetic storms are separated into two parts, depending respectively upon time measured from the commencement of the storm and upon local time. In the former the horizontal force is the element chiefly affected, a brief initial increase being followed by a much larger decrease, extending over several hours. Afterwards, during a period of days, the force slowly returns to its normal value. The local-time changes, after the ordinary diurnal magnetic variations have been removed, are approximately simple sine or cosine waves in all three elements. Their mutual relations in phase, and the dependence of their amplitudes upon latitude, are determined for twelve observatories from the mean of forty storms. The two sets of variations are interpreted in terms of electric current systems circulating in the upper atmosphere (with corresponding earth currents). These, again, are referred to the inductive action of a system of atmospheric motions. These motions are primarily vertical, though the unequal distribution of vertical velocity introduces horizontal movements also. The atmospheric motions are explained as the result of the precipitation of electric particles from the sun into the earth's atmosphere. A depression of the absorbing layer (which becomes ionised) is first produced. This is succeeded by a general upward expansion, due to the mutual repulsion of the particles (which are mainly of one sign of charge) which are entangled in the layer. The stratum in which these actions occur is considered to be above that in which the ordinary diurnal magnetic variations are produced, and the ionisation in the latter layer is attributed to the action of ultra-violet light from the sun.

Zoological Society, May 7.—Prof. E. W. MacBride, vice-president, in the chair.—Dr. B. **Petronievics**: Comparison between the lower jaws of the cynodont reptiles Gomphognathus and Cynognathus.—Miss D. M. A. **Bate**: A new genus of extinct Muscardine rodent from the Balearic Islands.

Royal Meteorological Society, May 15.—Sir Napier Shaw, president, in the chair.—C. E. P. **Brooks**: Continentality and temperature (second paper). The first part of this paper deals with the variation with latitude of the coefficients which give the influence of land on temperature. Land east, land west, and ice are considered separately, and it is found that in the tropics the coefficients are uniformly small. In the temperate regions in winter the effect of land to the east is also small, but land to the west has a well-marked effect in lowering temperature; this effect increases towards the poles. In summer, land both east and west increases temperature. In the second part the temperatures of land and water hemispheres are calculated. The distribution of land and sea at the beginning of the Great Ice age is then reconstructed from geological data, and on applying the formulæ calculated in the first part to this changed distribution, it is found that the temperature must have been lower than the present in different districts by various amounts up to 20° C. in January and 15° C. in July. These changes agree very closely with those required by geologists and palæontologists, and it is further proved that the Glacial period was a necessary consequence of the geographical changes. Finally, a theory of climatic evolution is outlined in accordance with these ideas and the theory of isostasy.—J. E. **Clark** and H. B. **Adames**: Report on the phenological observations in the British Isles during 1917. The persistent winter, scarcely broken over four and a half months from early December, dominated seasonal conditions. The chief practical result of the cold was indirect, the heavy destruction of bird-life favouring tree-blight and caterpillars, the ova of which were preserved by the unbroken cold. In many parts the latter stripped fruit trees and ruined garden greens. So, too, the antler-caterpillar plague in Derbyshire was ascribed mainly to the scarcity of rooks. On the other hand, berries and other fruits suffered little from birds. Other summer broods than garden white grubs were also favoured, especially Vanessidæ, including such rarer forms as the Common and White Admiral. From late July into September the splendid harvest prospects were much marred by rain, wind, and lack of sun. Final results were better than 1916, although grain crops fell some 5 per cent. below the ten-year average in England, rising, however, above elsewhere. As to roots, a warm, dry November more than made up for the cold, wet October; whilst potatoes gave a record crop with 8,600,000 tons off 1,364,000 acres, compared with 5,468,000 tons off 1,134,400 acres in 1916. Tree-fruits, too, gave excellent returns, the August gales proving prejudicial to apples only. Finally, November gave a splendid send-off for the coming year in the exceptionally favoured winter earing of the grain crops. This, as the president, Sir Napier Shaw, has shown, may be counted as half the battle in the prospects for successful harvesting. Table v. of the report gives the yearly floral means for the five chief districts from 1891. That year alone was later than 1917, namely, 9·6 days against 7·6 days after the mean flowering date, May 17·4. Birds and insects in table vi. confirm the lateness of 1917, averaging six days and twelve days behind; whilst table vii., of twenty-four migrants, shows nearly ten days' lag behind a twenty-year mean, 1877–96.

PARIS.

Academy of Sciences, May 6.—M. P. Painlevé in the chair.—P. **Termier**: Contributions to the knowledge of the tectonic of Asturias; Peñas de Careses; the Careses-Fresnedo anticlinal zone.—Th. **Schlœsing**, jun.: Ammonium nitrate as manure. In default of the opportunity of working on the agricultural scale, pot experiments are described, using equal weights of nitrogen as ammonium nitrate and ammonium sulphate, together with a blank experiment without ammonium salt. With maize, the nitrate gave slightly greater yields than with the sulphate. Some suggestions as to the best method of carrying out field experiments are added.—C. **Richet** and L. **Flament**: Urinary secretion troubles after great traumatisms. In seriously wounded cases there is a marked diminution in the urinary secretion and in the production of urea. The urea in eleven cases of mortally wounded fell to 30 per cent. of the normal, whereas in fifteen cases, seriously but not mortally wounded, the urea was 44 per cent. of the normal.—J. **Pérès**: Certain developments in series.—T. **Lalesco**: The application of integral equations to the theory of linear differential equations.—M. T. **Béritch**: An intuitive method for the detection of ordinary maxima and minima.—J. **Andrade**: Some point transformations, and the circle of similitude of two cycles.—R. **Bricard**: Movement with two parameters round a fixed point.—L. **Guillet**: The influence of cadmium on the properties of the copper-zinc alloys. With 60/40 or 70/30 brasses cadmium commences to affect the mechanical properties only when the percentage is 1 per cent. or more. Since commercial zinc rarely contains sufficient

cadmium to give 1 per cent. in the brasses made with it, the influence of cadmium has not much industrial importance.—G. **Lincio**: The stibnite and pyrites layer at Su Suergiu, Villasalto, Sardinia.—S. **Stefanescu**: A new method for the study of the phylogeny of mastodons, stegodons, and elephants.—H. **Perrotin**: The propagation of heat in the lower layers of the atmosphere.—P. **Lesage**: Contributions to the study of the germination of the spores of mosses.—E. **Bordage**: Observations on the nuclei of the trophocytes arising from the transformation of striated muscular tissue in insects.—P. **Remlinger**: The action of ether on rabies virus. The brain of a rabbit infected with the virus, after 120 hours' immersion in ether loses its pathogenic power. The brain readily forms an emulsion with physiological water after this treatment with ether, and this emulsion can be injected in large doses into animals without any danger. The immunity against rabies thus conferred appears to be lasting.

BOOKS RECEIVED.

An Enquiry into the Analytical Mechanism of the Internal Ear. By Sir T. Wrightson. With an Appendix on the Anatomy of the Parts Concerned, by Dr. A. Keith. Pp. xi+254+plates ix. (London: Macmillan and Co., Ltd.) 12*s*. 6*d*. net.

Tidal Lands: A Study of Shore Problems. By A. E. Carey and Prof. F. W. Oliver. Pp. xiv+284. (London: Blackie and Son, Ltd.) 12*s*. 6*d*. net.

Applied Optics: The Computation of Optical Systems. Being the "Handbuch der angewandten Optik" of Dr. A. Steinheil and Dr. E. Voit. Translated and edited by J. W. French. Vol. i. Pp. xvii+170. (London: Blackie and Son, Ltd.) 12*s*. 6*d*. net.

Astrographic Catalogue. Hyderabad Section, 1900·0. Vol. i., Measures of Rectangular Co-ordinates and Diameters of 63,436 Star-Images on Plates with Centres in Dec. −170. Pp. xliii+223. (Edinburgh: Neill and Co., Ltd.) 12 rupees or 16*s*. net.

Plant Physiology. By Prof. V. I. Palladin. Authorised English translation. Edited by Prof. B. E. Livingston. Pp. xxv+320. (Philadelphia: P. Blakiston's Son and Co.)

Flora of the Presidency of Madras. By J. S. Gamble. Part ii. (London: Adlard and Son and West, Newman, Ltd.) 8*s*. net.

The Neurotic Constitution. By Dr. A. Adler. Translated by Drs. B. Glueck and J. E. Lind. Pp. xxiii+456. (London: Kegan Paul and Co., Ltd.) 16*s*. net.

Library of Congress. Report of the Librarian of Congress and Report of the Superintendent of the Library Buildings and Grounds for the Fiscal Year ending June 30, 1917. Pp. 223. (Washington: Government Printing Office.)

A Text-Book of Inorganic Chemistry. Edited by Dr. J. Newton Friend. Vol. v., Carbon and its Allies. By Dr. R. M. Caven. Pp. xxi+468. (London: C. Griffin and Co., Ltd.) 15*s*. net.

Guide to the Insects of Connecticut. Part iii., The Hymenoptera or Wasp-like Insects of Connecticut. Pp. 824. (Hartford, Conn.)

Glossary and Notes on Vertebrate Palæontology. By Rev. S. A. Pelly. Pp. ix+113. (London: Methuen and Co., Ltd.) 5*s*. net.

British Medicine in the War, 1914–1917. Pp. x+138. (London: British Medical Association.) 2*s*. 6*d*.

L'Evolution des Plantes. By Prof. N. Bernard. Pp. xxxii+314. (Paris: F. Alcan.) 3.50 francs.

Sir William Ramsay, K.C.B., F.R.S.: Memorials of his Life and Work. By Sir W. A. Tilden. Pp. xvi+311. (London: Macmillan and Co., Ltd.) 10*s*. net.

DIARY OF SOCIETIES.

THURSDAY, MAY 23.

ROYAL INSTITUTION, at 3.—The Abode of Snow; Its Appearance, Inhabitants, and History: Sir Francis Younghusband.

INSTITUTION OF ELECTRICAL ENGINEERS, at 6.—Some Transient Phenomena in Electrical Supply Systems: Prof. E. W. Marchant.

FRIDAY, MAY 24.

ROYAL INSTITUTION, at 5.30.—Internal Ballistics: Lt.-Col. A. G. Hadcock.

LINNEAN SOCIETY, at 3.—Anniversary Meeting.

SATURDAY, MAY 25.

ROYAL INSTITUTION, at 3.—Problems in Bird-Migration: Prof. C. J Patten.

MONDAY, MAY 27.

ARISTOTELIAN SOCIETY, at 8.—The "Modes" of Spinoza and th "Monads" of Leibniz: Prof. G. Dawes Hicks.

ROYAL GEOGRAPHICAL SOCIETY, at 5.30.—Anniversary Meeting.

TUESDAY, MAY 28.

ZOOLOGICAL SOCIETY, at 5.30.—A Case of Hermaphroditism in a Lizard, *Lacerta viridis*: Noel Taylor.—Fresh-water Fish as Food: C. Tate Regan.

INSTITUTION OF PETROLEUM TECHNOLOGISTS, at 8.—The Application of Electrical Power to Oilfield Requirements: J. Wilfred Burford.

WEDNESDAY, MAY 29.

ROYAL SOCIETY OF ARTS, at 4.30.—Organic Chemistry in Relation to Industry: Dr. M. O. Forster.

THURSDAY, MAY 30.

ROYAL INSTITUTION, at 3.—The Abode of Snow; its Appearance, Inhabitants, and History: Sir F. Younghusband.

INSTITUTION OF ELECTRICAL ENGINEERS, at 6.—Annual General Meeting.

ROYAL SOCIETY OF ARTS, at 4.30.—The Cotton-mill Industry of India: Hon. Sir Dinshaw E. Wacha.

SATURDAY, JUNE 1.

ROYAL INSTITUTION, at 3.—Problems in Bird-migration: Prof. C. J. Patten.

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