THURSDAY, APRIL 1, 1909.

ALASKA.

Alaska, ein Beitrag zur Geschichte nordischer Kolonisation. By Prof. H. Erdmann. Pp. xv +223; with 68 figures and a map. (Berlin: Dietrich Reimer [Ernst Vohsen], 1909.) Price 8 marks.

IN this book Prof. Erdmann has prepared for the German public a concise account of the opening up of Alaska and its present condition. It is a story rich in interest to the student either of earth-lore or of sociology, and the theme arouses manifold reflections. What would happen, one wonders, if gold, or any other such commodity precious in the market, should be discovered in quantity in some still more inaccessible corner of the world—say, in north-east Greenland, or among the islands of the Parry archipelago, or on the Antarctic continent? Certain it is that no region where wealth may be easily gained has yet proved inaccessible to the adventurous throng. Such exploration has a purpose that is understood of every man, and has every man's support.

While the story of Alaska has the same old treasure-seeking plot that has served us for generations, we have never before had it in an Arctic setting. When Time has rounded off the saga, we shall find it to the full as romantic as any. Moreover, the circumstances of rush to the Yukon basin in 1896-7 are fraught with encouragement to those who have faith in the qualities of modern man. That tens of thousands of persons, without organisation and each on his own initiative, should, on the rumour of gold, have flung themselves into a distant and well-nigh resourceless wilderness of which the best informed among them had but little knowledge and the majority none at all; that they should have managed, somehow, either to establish and maintain themselves in the land or to make good their retreat without collective disaster; and that, from the self-interest of the units alone, there should have been evolved a system of transport and commissariat to meet their needs under conditions that had never before been faced—these things, surely, betoken the advance of individual and social powers in the race to a stage unattained in previous time.

It is not, however, from any contemplative aspect of this kind that Prof. Erdmann views his subject. His purpose throughout is practical and business-like, occasionally even political. One of his main objects is to demonstrate to his countrymen how valuable the resources of a northern land may be; how preferable to a tropical colony; and how profitable to the United States the purchase of Alaska from the Russians in 1867 has proved:—matters to be remembered should Germany have the opportunity to acquire a northern territory—Greenland, for example (p. 165). His journey through Alaska, made in 1906, was with the support of the Prussian "Kultusminister"; therefore it is perhaps essential that he should thus show its national utility.

With the advantage of his previous knowledge of the goldfields of Siberia and the Urals, the author was well qualified for the study of Alaskan mining conditions, and his book contains a clear description of the different modes of occurrence and different methods of winning the precious metal. The scientific explorations of the Canadian and U.S. Geological Surveys have made us acquainted with the main outlines of the geology and geography of the country, and are the basis of a voluminous literature which has recently been well summarised and catalogued in official publications of the last-mentioned survey. To this literature Prof. Erdmann acknowledges his indebtedness; and it is in the spirit of an observer of the known, not as an explorer of the unknown, that his book is written. While containing little that is scientifically new, it appeals to us as the well-written record of the impressions and experiences of a scientific traveller with an especially keen interest in the social and economic conditions of the new land. His outward journey followed the usual coast route from Seattle to Skagway; thence across the mountains by railway to the Upper Yukon and down the river to Dawson City. Resuming his river trip, he disembarked again at Circle City, in U.S. territory, and crossed the country westward by trail to Fairbanks, the centre of the new goldfield on the Tanana river. From Fairbanks he availed himself of the steamboat service, which brought him down the Tanana to the Yukon and thence to the coast, with only such minor adventures and discomforts by the way as are common incidents on new lines of traffic. On the coast at Nome he had opportunity to study the extensive gold workings in the beach deposits, after which he took ship and returned by the outer or ocean route to Seattle.

Like many another observer, he was shocked with the selfish and wilful destructiveness of the average gold-seeker, who, for the very smallest temporary advantage, has no scruple in burning down the thin but invaluable timber, thus perhaps permanently laying waste the land. How few men indeed are there as yet who have sufficient social conscience to be turned loose in the world untrammelled by enforceable laws! Symbolic of much was the fate of the head of a mammoth, regretfully mentioned by Prof. Erdmann (p. 129), that dared to interpose itself between an American citizen and pay-dirt.

On the other hand, the author is duly impressed with the vigour and adaptability of the colonists in all circumstances, and by their hardy spirit in the face of disaster, as exemplified in the rapid rebuilding of Fairbanks after its destruction by fire (p. 119). The conditions of labour are frequently discussed in the course of the book, with notes on the rate of pay, cost and mode of living, and methods of trade. The industries other than mining are touched upon, including the seal-hunting, salmon fisheries, attempts at agriculture, &c.; and the varied modes of transport in summer and winter are described. The author has a good eye for country, and depicts vividly and tersely its aspect along the routes traversed. He also gives some account of the aborigines—Indian and Eskimos—and of the influence of the colonists upon them. Quite shrewd

was the guess of the intelligent Eskimo here mentioned (p. 201), who from his respect for the prospectors' provision-cans opined that the mysterious phonograph might be "tinned white man."

The book is enlivened by personal incidents and anecdotes, and is abundantly illustrated by well-chosen photographs excellently reproduced. But the cover is ugly both in design and colouring.

G. W. L.

A TEXT-BOOK OF PHYSICS.

General Physics: an Elementary Text-book for Colleges. By Dr. Henry Crew. Pp. xi+522; figures. (New York: The Macmillan Co.; London: Macmillan and Co., Ltd., 1908.) Price 12*s.* net.

"IN these days of numerous text-books the author, who dares still further to increase the number, owes to the public, at least an explanation in which he shall set forth his purpose, however far short of accomplishment he may have fallen."

In these words our author introduces himself to us in his preface; and of the reasons adduced for the present volume the most important is that he has sought "not merely, or even mainly, to impart information, but to set before the student a large and compact body of truth obtained by a method which shall remain for him, throughout life, a pattern and norm of clear and correct thinking."

Prof. Crew has certainly succeeded in presenting a lively account of modern physics, in so far at least as it can be presented in a series of class lectures in which all experiments are of a qualitative nature only. We regret that he has not done more than this. It is quite possible in very many cases in class lectures to perform quantitative experiments also, and students are never so interested as when such experiments are being performed. There is no suggestion of this in the book before us. This is to be regretted, because, even if in the lectures which the student is privileged to hear qualitative methods are alone presented, yet his text-book should provide him with a detailed account of some of the historical experimental methods by which the present state of science has been attained. We do not quarrel in general with what we find here, but with what is omitted. Open where we may, and it is rare that we find what we hoped. Thus, in connection with Charles's law for gases:—

"The actual measurement of these quantities is a somewhat difficult matter, requiring many precautions, and may well be reserved for the student's second or third year in physics."

We are astonished that this should be thought to be advisable.

Conspicuous gaps also exist in the exposition. After emphasising the fact that speed is the *limiting value* of a ratio of distance over time, and the importance of a knowledge of limiting values even in elementary physics, Prof. Crew does not make the slightest effort to impart this knowledge. How easy and instructive it is to take one or two cases as illustrations, such as $y=\kappa t$ or $y=\kappa t^2$, and calculate the speeds from them. The student thereby learns something, whereas, at present, the matter is left with an air of mystery hanging over it.

We are not enthusiastic admirers of D'Alembert's principle; it is correct but confusing, introducing a fictitious equilibrium where equilibrium does not exist. But, at the early stage of instruction covered by the book, to speak of the reversed effective forces as the reaction of the masses against their acceleration immediately after having given Newton's law of action and reaction (the reaction acting on a second body) is only to make confusion worse confounded.

Prof. Crew follows everyone else in defining energy as power of doing work. In view of the fact which everybody recognises, that a body may have enormous stores of energy and yet have no power of doing work, is it not time that the customary definition should be revised? The present writer is accustomed to define it as "that which diminishes when work is done, by an amount equal to the work so done."

The formula for a simple pendulum is written $T=2\pi\sqrt{l\theta/(g\sin\theta)}$, as though this was the exact form, the usual approximation following it; of course, this is not the case.

Pascal's theorem for fluid pressure is given as "At any point in a liquid at rest the stress (pressure) is the same in all directions." This is not the principle which usually goes under the name of Pascal's theorem.

The subject of magnetism is started with the definition, Any body which attracts iron filings is said to be magnetised and is called a magnet. Surely something more satisfactory than this can be found in the way of a definition. Those of us who have had considerable experience in examining are very familiar with the candidate who presses the passion for the unification of knowledge so far as to consider identical all forces of attraction. The present writer has been told by many dozens that we know the earth to be a magnet because if it were not so and we were to jump out of a window we should not fall down.

Looking back over this review, the writer feels that adverse criticism preponderates in it. He does not wish to convey the idea that the book must be condemned, but to show where it might be improved. He has read it from cover to cover (except the index); there is a certain breezy informality about it which is somewhat pleasing, although, to an English ear, a few of the expressions suggest slang.

Prof. Crew has evidently considerable interest in the historical side of the subject. Every leading principle is attributed to its source and is dated. He takes special pains to introduce each section by allusion to facts of familiar experience, and then endeavours out of this "chaos" to produce scientific order. This method serves to stimulate interest, and deserves commendation.

The book includes the whole range of physics; the part on mechanics (205 pages) bears, perhaps, an excessive ratio to the rest.

SPHERICAL ASTRONOMY.

A Treatise on Spherical Astronomy. By Sir Robert Ball, F.R.S. Pp. xii+506. (Cambridge: University Press, 1908.) Price 12*s.* net.

IT is difficult to decide what limits an author should set himself in writing a text-book on this subject. Gravitational astronomy on the one hand and descriptive and general astronomy on the other should be, for the most part, omitted. A more difficult question arises as to what details of practical astronomy should be included. It seems to us that the aim of such a book should be to show how the geometrical positions of stars and other heavenly bodies are defined and accurately determined, and how these positions vary with the place and time of observation, and from such causes as refraction and aberration. Some description of the more important instruments, *e.g.* the transit circle, the equatorial, theodolite, and sextant, should be included, and preferably in connection with the class of astronomical problem to which they are applied, and the geometrical problems to which they give rise or which arise in connection with them. The excellent little book, written by Sir Robert Ball in 1877, fulfils this condition. Godfray's "Astronomy" is incomplete and antiquated, but in this way is an admirable manual for students.

In the work under review the instruments are considered as particular cases of the "generalised instrument." This mode of treatment is of considerable geometrical interest, but it does not give the student an adequate idea of the use of astronomical instruments or the parts they play in astronomical investigations. As the author explains in the preface that he proposes to avoid the multitudinous details of practical astronomy, this criticism is perhaps beside the mark, but the student will, we think, need to read concurrently with this work one on the outlines of practical astronomy. The most striking illustration of the difficulties which arise from the separation of the geometrical problems from the instruments which furnish their data is found in the scanty treatment of the determination of latitude and longitude. With the exception of Sumner's method, only incidental references are made to a subject which requires at least one chapter for an account of the various methods applicable under different conditions.

Within the limits the author has imposed on himself, the book will be found very useful by students whose mathematical attainments are sufficient to obtain a first class in the mathematical tripos at Cambridge. The author usually treats questions generally and analytically, and then proceeds to transform, simplify, and approximate. This method is naturally and necessarily employed in treatises, such as Chauvenet's, intended for the actual requirements of astronomers, and is the simplest for students to whom the mathematics does not present difficulty. For other students more elementary methods applied to the simplest cases will be found necessary.

A valuable feature of the work is the constant introduction of the numerical values of the astronomical constants, and the frequent solution of numerical examples. The short exposition of the art of interpolation properly finds a place in the book.

In the chapter dealing with the use of spherical coordinates, it is pointed out that the direction of graduation of a circle enables the two poles to be distinguished, and the use of the word *nole* is suggested for the one generally called the North Pole. Such a term is a useful one, as the words North Pole can then be restricted to the actual North Pole of the heavens.

We are glad to see that a short account is given of the theory of map-making. It is very desirable that a knowledge of the principles on which maps are constructed should be more widely known, and not confined to students of pure mathematics.

Attention may be directed to the chapter on refraction. This subject presents difficulties both to the astronomer and the teacher. The theories of Bessel, Gylden, and Radau are too complicated for a text-book, and yet the importance of the subject demands more than is usually given when these are omitted. The author, who gives a simple approximate integration of the differential equation of refraction (for which he expresses his indebtedness to Prof. E. T. Whittaker), has presented the whole question in a satisfactory and adequate manner.

The geometry of such questions as aberration, parallax, and occultations is well presented. Generally speaking, the book will be found very useful both by teachers and students in all applications of spherical trigonometry to astronomy. The collection of exercises is well chosen, and the numerical applications, both in the text and among the exercises, serve to give a real connection between the mathematical formulæ and astronomical phenomena. F. W. D.

THE CELL AND ITS WORK.

The Cell as the Unit of Life, and other Lectures delivered at the Royal Institution, London, 1899–1902. *An Introduction to Biology.* By the late Allan Macfadyen. Edited by Prof. R. Tanner Hewlett. Pp. xvi+381. (London: J. and A. Churchill, 1908.) Price 7*s.* 6*d.* net.

THE volume before us is the outcome of courses of lectures delivered some years ago by the late Dr. Allan Macfadyen in his capacity of Fullerian professor of physiology in the Royal Institution. Naturally, owing to the time that has elapsed since they were delivered, some modification must have been rendered necessary, and Prof. Hewlett, who has undertaken the task of editing the book, is to be congratulated on the way in which he has performed his part.

The lectures themselves deal principally with the cell as the morphological and physiological unit of organic life. The author strongly emphasises this point of view. It is one which, in our judgment also, still affords the most comprehensive as well as the most effective grasp of the problems presented by living beings, notwithstanding the attacks that have been from time to time directed against it. The

manifold and complex phenomena of life must, in the last analysis to which we can for the present hope to submit them, be considered as attributes of cellular activity.

"There is a solidarity in the essential phenomena of life which is shared not only by the simple Amœba, but by the most specialised cell in a tissue of the human body."

As might be anticipated by those who will now become acquainted with the lectures for the first time, the consideration of the ferments, toxins, and other properties of the cell occupies an important part of the whole work. Prof. Macfadyen is best known by his investigations in this department of biology, and even if the point of view has somewhat changed during the last few years, it is hardly possible to read the book without profit. The method of treatment, as befits a course of lectures of this kind, is necessarily somewhat elementary, but it is not by any means superficial, and the thread of the argument can easily be followed by anyone, even though he have no special previous knowledge of the subject.

Great insistence is placed on the distinction between the reactions of living protoplasm and the molecular groups that arise out of it when the attribute of life has been lost. This is not always remembered sufficiently by some who would reduce all the phenomena of life to proximate questions of contemporary chemistry and physics, without reflecting on the limited area of these sciences that has been explored up to the present time.

"A great part of physiological inquiry has consisted in the examination and explanation, *not* of life but of the mechanism of life, and so far as this mechanism is concerned, adequate and satisfactory explanations have been found in the ordinary laws of physics. It is when we come to cellular activity that our real difficulties begin as regards the essentially vital problems."

Of course, this does not affect the truth of the statement that the greatest real advances have been actually made along the paths indicated by chemistry and physics, but rather that these two sciences occupy themselves as yet with relatively simple problems, whilst those that confront the physiologist are so complex that means have not as yet been discovered, at least in most instances, to split them up into those simpler and more manageable components into which analysis will one day assuredly cleave them. It may be that the requisite tool will be fashioned as the result of the investigations on ferments that are now being so energetically studied. At any rate, researches on these bodies are yielding, at the present time, results of far-reaching importance, and we have come to realise that it is by their agency within the living cell that many of the reactions that used to be associated essentially with "living" substance are demonstrably brought about.

The lectures deal with these and other topics. The style is always interesting, and the book may well claim to form an introduction to a study of some of the fundamental problems of biology, if not to biology itself.

INTERNAL COMBUSTION ENGINES.

(1) *The Internal Combustion Engine.* By H. E. Wimperis. Pp. xiii+326. (London: Constable and Co., Ltd., 1908.) Price 6*s.* net.

(2) *Internal Combustion Engines, their Theory, Construction, and Operation.* By R. C. Carpenter and H. Diederichs. Pp. xiv+597. (London: Crosby Lockwood and Son; New York: D. van Nostrand Co., 1908.) Price 21*s.* net.

(1) THE developments of the theory and practice of engineering in relation to the internal-combustion engine have been so rapid in the last few years that old text-books are practically obsolete, and the serious student of this fascinating subject can only obtain trustworthy information by consulting a mass of original papers. The present text-books are of the class which will appeal to advanced students of engineering, and will also be welcomed by engineers who, without having a specialist knowledge of the subject, wish to keep abreast of modern developments.

Mr. Wimperis has dealt very successfully with a considerable range of theory and practice, and, in a moderate compass, has given a clear account of the theory of the internal-combustion engine. The distinctive feature of the early part of his work is the development of the thermodynamic equations on the assumption that the specific heat of the charge varies linearly with the temperature.

Modern research on the specific heats of gases at very high temperatures shows that a theory based on an invariable specific heat is so incorrect as to make the standard of reference of little value.

The exact way in which the specific heat of the charge varies has not been settled in a satisfactory manner, and it appears that the law of change is not a linear function of the temperature; but in the present state of our knowledge the extra complication produced by a parabolic formula is not warranted. The second section of the book is devoted to the construction and operation of gas engines and producers, and covers a fair range of practice. Some of the sections, such as that on the balancing of engines, merely touch the fringe of the subject, but balancing could not be adequately treated without materially adding to the size of the book.

We think that the author might have devoted more space to the consideration of indicators, especially to those which have developed from the diaphragm indicator invented by Prof. Perry, and which in their modern forms have become so important in tests of high-speed engines of all kinds.

Oil and petrol motors are dealt with in the final section of the book, and considerable space is devoted to carburettors, ignition, rating of petrol motors, and their efficiency. The book is clearly printed, the illustrations are well chosen, and it is one of the most interesting and readable works which has appeared for a very long time.

(2) The work by Profs. Carpenter and Diederichs, of Cornell University, is on a more extensive scale, and is based on a course of lectures to engineering students at Sibley College. It is therefore written

more from the point of view of a teacher, and, in its early chapters, the theory of the internal-combustion engine is developed on the assumption of a constant specific heat. Later the variation of the specific heat with temperature is discussed in general terms, and the results of Clerk, Mallard, and Le Chatelier are given.

The principal feature of the work, however, is the very full account of the growth and development of the internal-combustion engine in America.

All the well-known types are described and generally very fully illustrated. In this respect the work is somewhat encyclopædic in character, and ought rather to be regarded as a reference book than a text-book. The same remark applies to other sections devoted to fuels, testing of engines, methods of regulation, gas-engine auxiliaries, and the like. In all these we find a mass of information, with copious references to the original sources.

Anyone wishing to obtain a good general idea of present-day practice in America will find this book a valuable work. E. G. COKER.

OUR BOOK SHELF.

Abhandlungen zur Physiologie der Gesichtsempfindungen aus dem physiologischen Institut zu Freiburg-i-B. Herausgegeben von J. von Kries. Drittes Heft. Pp. 192. (Leipzig: Verlag von J. A. Barth, 1908.) Price 6 marks.

THIS volume comprises the third series of collected papers from the laboratory of Prof. von Kries at Freiburg. The communications have all been previously published in the *Zeitschrift für Psychologie und Physiologie der Sinnesorgane*, the earliest having appeared in 1903. It is doubtful whether their republication in this form will lead to recognition by a larger audience, not because of any lack of inherent excellence, but rather because of their highly specialised nature.

The first paper is an interesting note on the perception of flicker in normal and totally colour-blind persons. The researches of Schaternikoff tend to show that the retinal rods possess a lower sensitivity for rapid periodic variation in the intensity of the incident light than the cones; hence more rapid rotation of the disc in the usual method of eliciting the flicker phenomenon is necessary to produce complete fusion with the eye adapted for light than with the dark adapted eye. It became of interest, therefore, to investigate the behaviour of the totally colour-blind eye in these circumstances. At the suggestion of Prof. von Kries, who had not a suitable case under his observation, Prof. Uhthoff carried out some investigations. He found that much more rapid rotation—about three times—was necessary with the normal eye to eliminate flicker than with the totally colour-blind eye.

Porter has investigated the relationship between the intensity of illumination and the frequency of change necessary to eliminate flicker. He found that the curves representing this relationship show two parts, each nearly straight, but having two different constants. These curves are analogous to those obtained by König for the relationship between visual acuity and intensity of illumination. In the one case the fusion frequency, in the other the visual acuity, is proportional to the logarithm of the illumination. Both, therefore, behave in identical fashion: with the smallest intensities of light both increase slowly; at approximately the same intensity a much more rapid increase suddenly becomes apparent. The simplest explanation of these phenomena is that there are two mechanisms at work, one of which is influenced by light of low, the other by light of higher, intensity.

In succeeding papers Dr. Wilhelm Trendelenburg records quantitative estimates of the bleaching of visual purple by monochromatic light and (with Dr. Roswell P. Angier) of mixtures of complementary colours to form white. Siebeck has investigated the intensity of monochromatic light in extremely small fields, so small, in fact, as to eliminate the colour element (Minimalfeldhelligkeit). Prof. von Kries, in a paper founded on observations by Dr. Eyster, calculates in absolute terms the energy necessary for stimulation of the retina, and Dr. F. P. Boswell applies the same principles to the fovea. They thus attempt what has already been done for the ear by Lord Rayleigh and others. Other papers on colour mixtures and colour memory will repay perusal, and Prof. von Kries describes a simple apparatus for the mixture of monochromatic lights which may be commended to the notice of teachers of physiological psychology.

Fresh-water Algae from Burma, including a few from Bengal and Madras. By W. West and G. S. West. Pp. 175–260; 7 plates. (Annals of the Royal Botanic Garden, Calcutta, vol. vi., part ii.) Price Rs. 10, or 15*s*.

THE material was collected in certain districts of Burma, and a few species in the Burdwan district of Bengal and Vizagapatam district of Madras by Mr. I. H. Burkill, and was forwarded for determination by Lieut.-Col. Prain, at that time director of the Botanical Survey of India. The work is almost entirely systematic, as would be expected in dealing with material from districts where the algal flora was previously almost unknown, and has added very materially to our knowledge of the distribution of fresh-water algæ in the Indian region. Two new genera are described—Euastridium, a large and handsome Desmid, possessing peculiar morphological features, and Burkillia, belonging to the Protococcaceæ, occurring as free-floating colonies furnished with stout horns. Among the many new species described, *Mougeotia producta* is of special importance because of the presence of aplanospores in no way different from those which are found in the genus Gonatonema. In the last-named genus aplanospores only are formed, whereas in Mougeotia, aplanospores and spores, as a result of conjugation, are both present, hence it may be necessary to place Gonatonema merely as a section of the genus Mougeotia, in which spores resulting from conjugation have ceased to exist. *Urococcus tropicus* is remarkable in being green, whereas the cells of other species of the genus usually contain an abundance of a red-brown pigment.

The collection contained a number of interesting Desmids which, with previous records, are said to furnish material for a very interesting discussion on their distribution in the East Indies generally. Even from the knowledge forthcoming, certain Desmids appear to be confined to an area extending from India and Ceylon, across Burma and the Malay Peninsula to Sumatra and Java, and thence to Queensland.

As evidence of the wide geographical range of some species of algæ, *Nostoc humifusum*, first recorded from Scotland, and *Plectonema wollei*, from the United States, were included in the collection.

The number of varieties and forms hovering around many of the species suggests that, from the standpoint of de Vries, many incipient species are being produced.

The work is a perfect model of descriptive or systematic botany, combining a true sense of proportion, the authors' well-known grasp of their subject enabling them to deal primarily with the material under investigation, and, secondly, with the book phase of the subject known as synonymy.

Seven beautifully executed plates elucidate the text.

Trees: a Handbook of Forest-Botany for the Woodlands and the Laboratory. Vol. iv. Fruits. By the late Prof. H. Marshall Ward. Pp. iv+161. (Cambridge: University Press, 1908.) Price 4*s.* 6*d.* net.

IT was the intention of the author to complete this work in six volumes, but unhappily he was not spared to see the scheme accomplished. However, three excellent volumes, full of useful and interesting information, dealing respectively with buds, leaves, and flowers, had been published, and the author left behind sufficient manuscript for two other volumes. Prof. Groom undertook the task to see these two volumes through the press. A perusal of the present volume shows that the manuscript could not have fallen into better hands. The skill with which he has edited this part leaves nothing to be desired. Like its predecessors, vol. iv. is divided into two sections—a general and a special. The first section contains seven chapters. The first chapter gives an idea of what fruit is, its function and parts. In the second chapter is given a classification of fruits, and the remaining chapters of this section deal with the fruits of woody plants, each under its own natural order. In section ii. we have a tabular classification of trees and shrubs according to their fruits and seeds.

The many excellent illustrations given throughout the volume serve to enhance its value as a book for students and others who may wish to study fruits, and it will also be found of service for the purpose of reference.

The next and final volume is already in the press, and when issued will complete a monumental work on trees written by an enthusiast as only one who is imbued with the love of his subject can write.

"Trees," by Prof. Marshall Ward, will be found of use to the expert and student alike, while the beginner who has once started to read will soon find himself becoming enthusiastic under the inspiring influence of the writer.

A complete index has been compiled for this as well as for the other volumes by Mrs. Marshall Ward.

The Story of Iron and Steel. By J. Russell Smith. Pp. xi+193. (London: Appleton and Co., 1908.) Price 2*s.* 6*d.* net.

To all who are interested in the gradual development of our great iron industries, and especially the more recent development in America, this little volume may be of some interest. It, however, can hardly be said that the author has succeeded in carrying out the object he had in view, as stated in his preface, of presenting to intelligent persons a clear and concise description of the complex technical phenomena of iron- and steel-making. The author's apparent lack of detail technical knowledge has prevented his emphasising in his descriptions the fundamental principles involved in the various processes to which he refers. Thus, in dealing with the reduction of iron as it was practised during the various stages of development in passing from the catalan forge to the modern blast furnace, there is not the slightest suggestion made that there is any chemical reaction between the iron ores and the fuel employed, and the lay reader would go away with the impression that the only function of the carbon, in whatever form it was used, was to act as a heating agent.

On p. 99, in dealing with the quality of iron produced, he makes the statement that if the iron is *melted* at 800° centigrade, it will contain 1 per cent. of silicon, which is, of course, an absurdity, as this temperature is below the melting point of iron. A page or two further on he speaks of the hot blast being injected into the furnace at 800° or 1100° centigrade.

His description of the puddling furnace is of the crudest when he speaks of the carbon in the pig-iron being combustible and gradually burnt out by the flame, while no suggestion is made that the real oxidising agent is the oxide of iron added. In chapter xi., "On the New Steels and their Significance," in which he refers to various alloy-steels, he seems to be under the impression that the self-hardening properties of high-grade steel tools are a function of their melting points, and his statement as to certain influences of manganese on steel certainly has the single advantage of being distinctly novel.

It is to be regretted that the technical descriptions in this little volume are so inaccurate, as in other respects it is a very interesting synopsis of the progress of the iron and steel industry. Perhaps the most interesting portions of the book are those chapters dealing with the various causes which have influenced the great developments in recent years in America, and also induced the rise and growth of the great financial trusts that now so largely control steel manufacture in the States.

Physiological and Medical Observations among the Indians of South-western United States and Northern Mexico. By Aleš Hrdlička. Pp. ix+460. (Washington: Government Printing Office, 1908.)

THIS publication is a bulletin of the Bureau of American Ethnology (Smithsonian Institution), and comprises the result of observations among a large number of Indian tribes. It will prove a mine of useful information to those interested in anthropology, but, like the publications of most Government institutions, is hardly written in a manner to make it interesting to the general reader. It contains, for instance, nearly 200 pages of statistical tables. Its title—physiological and medical observations—is justified because the data collected include what is so often missing in books on ethnology, details not only of size, stature, date of puberty, rate of pulse, muscular development, and so forth, but also statistics relating to prevalent diseases and native methods of treatment. Not the least attractive feature of the work is a series of twenty-eight beautiful plates, which illustrate the physiognomy and dwellings of the native races, as well as other points interesting to those who study folk-lore.

The author appears to have spared no pains in carrying out his investigations.

Ernst Haeckel. Versuch einer Chronik seines Lebens und Wirkens. By Prof. Walther May. Pp. vii+301. (Leipzig: J. A. Barth, 1909.) Price 5·60 marks; bound, 6·60 marks.

THERE are already two biographies of Haeckel, but Prof. May's book is complementary to these, and written in a different mood. It aims at showing what the great naturalist has accomplished, from his first research in 1855 to the institution of the Phyletic Museum in 1907. The author gives a careful account of the chief results of Haeckel's books,

including the "Generelle Morphologie," and shows us—rather by a statement of facts than by any formal estimate—the influence Haeckel has had on modern biology and on the intellectual outlook generally. He does not hesitate to quote the hardest things that have been said of Haeckel's physics and metaphysics, and even of his biology, but he gives us something of the defence as well. The quotations from irresponsible authors might have been left out, as well as all the verses from "Jugend," "Kladderadatsch," and the like, which seem out of keeping with the serious character of the book. It is a restrained and careful piece of work, tending, perhaps, to exaggerate the importance of Haeckel's later writings, but marked by unusual objectivity and impartiality of statement. There is an excellent bibliography.

Ventilation for Dwellings, Rural Schools and Stables. By F. H. King. Pp. iv+128. (Madison, Wis.: Published by the Author, 1908.) Price 75 cents.

PROF. KING knows the value of experimental demonstration in explaining scientific principles, and makes excellent use of it in his little book. The interesting treatment of the facts upon which successful ventilation depends, and the application of theoretical conclusions to practical problems, should make the book useful to a wide circle of readers. The supply of pure air is of vital importance in all the circumstances with which the book is concerned, and the volume may be commended specially to parents, teachers, and stock owners.

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.]*

Temperature of the Upper Atmosphere.

SINCE my letters which appeared in NATURE on March 12 and July 30, 1908, you have published various communications on this subject. In your issue of March 18, p. 68, Mr. E. Gold contributes a mathematical calculation of the possible size of the difference between the temperature of the surrounding air and that of the balloon or the thermometer. His conclusion, if I rightly understand him, is that under the conditions which he postulates it is impossible for a thermometer of the Hergesell pattern to differ from the temperature of the surrounding air by sensibly more than 2° C.

In my last letter I specified actual cases in which *differences* larger than 2° C. had been observed between two thermometers of different types sent up with the same balloon, on occasions when a comparison of falling and rising readings seemed to show the impossibility of explaining this by mere errors of graduation. The causes which Mr. Gold investigates would naturally affect the two thermometers in the *same* direction, so that the difference between them is presumably an underestimate—possibly a large underestimate—of the disturbing influences exerted on the thermometer most affected. This does not, of course, necessarily invalidate the accuracy of Mr. Gold's work, because the conditions which he postulates may have been violated during the ascents in question; but I have no reason to suppose that I hit upon ascents which could reasonably be regarded as of a wholly exceptional character at the stations concerned. Out of the considerable number of records which I examined, there were only a few which gave data from two thermometers, and there seems no reason to suppose that the physical conditions on these occasions were exceptional. Considering the many uncertainties in the physical data available at present, I am afraid that any mathematical calculation must be received with considerable reserve so far as practical applications are concerned.

I am glad to see, both from his letter and from a recent paper in the Proceedings of the Royal Society, that Mr. Gold prefers to speak of an isothermal *region* rather than of an isothermal *layer*; but I would invite him and other active meteorologists to take yet a second step, and discard the term *isothermal*. What the *instruments* usually suggest—rightly or wrongly—is, as I pointed out before, not uniformity in temperature, but an inversion of temperature. It is surely ridiculous to apply the term *isothermal* to the phenomena observed at Uccle on July 25, 1907, during the highest ascent yet effected (*Meteorologische Zeitschrift*, February, p. 88). During the ascent temperature fell from +13°·5 C. at 360 metres to −56°·8 at 12,112 metres. Then came, according to the records, an inversion, temperature rising until at 26,557 metres, the greatest height attained, it was −42°·3, or 14½° C. above the minimum. The temperatures recorded during the fall agreed remarkably with those recorded at the same heights during the ascent, thus affording—as is pointed out in the *Meteorologische Zeitschrift*—strong support to the view that the ventilation was throughout sufficient. It is surely a misuse of words to apply the term *isothermal* to a region of which different portions—according to the only evidence available—differ in temperature by at least 14½° C. The records from some ascents even raise doubts as to whether, above the height of inversion, the temperature gradient is always and everywhere very small. The Uccle record above referred to showed a rise of 6° C. during the ascent from 12,112 metres to 13,000 metres, and a fall of 5°·6 C. during the descent from 13,000 metres to 12,000 metres.

C. CHREE.

March 20.

The Encouragement of Research.

I TRUST that you will permit an appeal to be made to those of your readers who believe that the encouragement of scientific research is a matter of national as well as of local importance.

The new buildings erected by the council of this college in the Cathays Park, Cardiff, are now approaching completion, and a special feature of those buildings is a laboratory dedicated wholly to the purposes of scientific research.

The erection of the whole of the new college buildings, according to the designs of Mr. Caroe, would involve an outlay of close upon 250,000*l*. The council has not considered it possible, at the present time, to undertake such an expenditure, but has sanctioned the completion of the buildings assigned to the arts, the administrative and the educational departments, the library, and the research laboratory. The erection and equipment of this portion of the buildings involves an expenditure of nearly 140,000*l*., of which about 100,000*l*. has been secured. A special and strenuous effort is now being made to raise from local sources the 40,000*l*. immediately required.

In such circumstances it is felt that any attempt to secure in this district, at the present time, the amount necessary for the equipment and modest endowment of the research laboratory might react injuriously upon the prospects of the special effort to which reference has already been made.

I venture, therefore, to appeal to those of your readers who, although not directly interested in educational matters in this district, feel that the encouragement of research is a national duty, to assist the movement for obtaining the necessary equipment for the suitable and handsome edifice which is being provided by local generosity and dedicated by the council of the college to the purposes of scientific investigation.

A collection of physical apparatus has already been presented to the laboratory, but as it is of a somewhat specialised nature it can only be regarded as a nucleus.

All donations received in answer to this appeal will be devoted solely to the equipment and upkeep of the research

laboratory. They may be paid to the treasurer of the college or to the undersigned.

E. H. GRIFFITHS.

University College of South Wales and Monmouthshire, Cardiff.

Research and the Colleges.

IT is evident that the question of subject-matter for research is still a difficult one, and that our colleges are still unable to meet it. In the meantime, it is essential that the students should be instructed in such procedure, unless the matter is to be shelved until some outside source of supply can be obtained.

I would suggest that class research be instituted on the following basis. The senior students, divided into groups of, say, four, would engage in some well-recognised research of a classic nature, which would be selected from the published work in this direction. It must follow, I think, that the difficulties met with by the original investigator would come to the surface, and be followed by the students step by step.

The different groups in class would at intervals examine each section's work, and be instructed generally in the same by the staff. By a careful selection, and in this way, the work coming before the students might cover research in pure chemistry, and technical or industrial research as well.

From the industrial side of the question, it seems that Prof. Kipping's recent criticisms on the Institute of Chemistry for not insisting that the subject of original research shall be compulsory are a little premature, while the colleges themselves do not do more in this direction. From this point of view the institute might insist that all senior students shall be instructed in the methods of research in a practical and thorough way, and might refuse to "recognise" any college not conforming to this regulation. With the above method of class research this training is available. The fact is often lost sight of that the more important the nature of industrial research the less possible is it to publish it, even to the examiners themselves. Thus the opposite conditions obtain from those in the colleges, but the mass of this hidden research is of far greater value and importance than that which is published from these institutions, at any rate to the present generation.

W. P. DREAPER.

Fall of an Aërolite in Mokoia, New Zealand, on November 26, 1908.

BY the kindness of Mr. J. T. Ward, honorary director of the Wanganui Observatory, and Mr. G. R. Marriner, curator of the museum at the same place, I have received particulars of the aërolitic fall of November 26 last, together with several fragments of the object. Perhaps it will be best to quote from their accounts:—

The flash of the meteor was seen at 12.30 p.m. to 12.35 p.m. (civil time, 11.30 fast on Greenwich), and the loud detonations were heard by many persons distributed over more than 100 miles of coast-line and for a considerable distance inland. The object left a streak like a line of smoke or steam, which broke into three portions and drifted apart before it disappeared in about five minutes. The sound appeared to follow the flash after a minute or more, and formed a combination of booming with sharp cracking sounds, similar to that produced by thunder and discharges of musketry. The observed flash, or meteor-flight, occupied the following position as ascertained by Mr. Ward from various observers:—250°−30° to 220°−5°.

At Stratford, twenty-five miles from the place of the meteor's descent, the noise was very loud, and startled the horses and cattle, as well as many persons who were in the open and amid quiet surroundings. Mr. Marriner visited Mokoia and recovered two fragments of the body, but a third, which was seen to fall in a plantation, could not be found owing to the thickness of the bush. The pieces secured were 4½ lb. and 3 lb. in weight, and the former fell at the foot of a tree, splintering a part of it and making a hole in the ground about 15 inches deep. Mr. Marriner estimates the whole weight of the meteorite which fell on Mr. Hawkins's estate as 12 lb., but as disintegration occurred before its descent, the original body was much larger, and it is to be hoped that other fragments will be found after more careful examination of the district.

The portions received by me are composed of a very dark grey stone or admixture of stone and iron, which has evidently undergone intense heat, and seems of a crumbly nature. The analysis of the meteorite is being made at Wanganui, and will be published shortly. After circulating in space for probably countless ages, it had apparently ceased its rovings when it struck the root of the tree in Mokoia and penetrated about 15 inches below the soil; but it was destined for a further flight from one side of our globe to the other, for it has just completed its transit of about 13,000 miles to Bristol!

It is interesting, after a person has habitually watched the luminous careers of these bodies during many years, to hold a similar object in one's hand and contemplate it from a much nearer point of view!

Bristol, March 19. W. F. DENNING.

Early References to Fluorescence and Light transmitted by Thin Gold Films.

PETRO VAN MUSSCHENBROEK, in his "Elementa Physicæ," after a discussion of the colours of thin films, proceeds:—"id quoque conspicuum est in infuso Ligni Nephritici, quod pro diverso tam oculi, quam lucis situ, alio colore apparet" (p. 393, second edition, Leyden, 1741).

This clearly could not have been an instance of ordinary interference colours, and it occurred to me that we might have here an early observation of fluorescence.

Inquiries kindly made for me by Mr. Harold Evans have elicited, in a letter to the *Gardeners' Chronicle*, the facts that the wood *Lignum Nephriticum* was shown in the Paris Exhibition of 1855, that its source is some Mexican tree, but that this tree was not identified, at any rate in 1871. In the Admiralty Manual of Scientific Inquiry for that year information as to its origin is asked for, and it is stated that "its infusion is remarkable for having the blue tint seen in a solution of quinine."

This seems to confirm definitely my conjecture that van Musschenbroek had observed fluorescence at least ninety-two years before it was recorded in alcoholic chlorophyll solutions by Brewster, and more than one hundred years before Herschel described it in solutions of quinine sulphate.

Can any of your readers throw any further light upon the nature of *Lignum Nephriticum*?

In the next sentence after the one quoted above van Musschenbroek alludes to the blue colour of the light transmitted by very thin films of gold:—"tum Auri lamellae tenuissimae ante Microscopium positae; per quarum poros Lux caerulea tantum transit."

JOHN H. SHAXBY.

University College of South Wales and Monmouthshire, Cardiff, March 22.

Another Fossil Tsetse Fly.

IN NATURE, August 22, 1907, I reported the discovery of a tsetse-fly (Glossina) in the Miocene shales of Florissant, Colorado. In going over the materials collected in the same locality in 1908, I find a second species of the same genus. It is preserved showing the lateral aspect, the abdomen arched dorsally, and the proboscis evident, though imperfect. It is about 10⅛ mm. long, the wing 7 mm., thus much smaller than *G. oligocena*. The venation is perfectly typical for Glossina, but the first basal cell bulges less subapically than in *G. oligocena*, its maximum breadth or depth being only 323 micromillimetres. The vein bounding the outer side of the discal cell has a double curve, as in the Œstridæ.

For the new species I propose the name *Glossina osborni*, after Prof. H. F. Osborn, the distinguished palæontologist.

T. D. A. COCKERELL.

University of Colorado, Boulder, Colorado, March 15.

HINTS FOR NATURE-STUDY.[1]

(1) MRS. BRIGHTWEN was one of the pioneers in the art of making young people acquainted in a pleasant way with the plants and animals round about them, and we wish to express our opinion that the mood and method of much of the "Nature-Study" which has been hurriedly set a-going in schools to-day is right or wrong just as it agrees or differs from what we find in the simple and homely studies by the author of "Wild Nature Won by Kindness." We say this very deliberately, although, to tell the truth, there is not much in the particular book before us, which must be treated tenderly, as its title suggests, and for the sake of what has gone before. But even here we find some of the qualities which distinguish sound nature-study—fidelity to observed fact, appreciation of the wonder and beauty of common things, and insistence on interpretation rather than information. The book shows how problems of a simple sort may be solved in simple ways, given patience and a window-sill.

(2) We have also before us a beautiful popular edition of Mr. R. Kearton's "Adventures of Cock Robin and his Mate"—a book for boys and girls, which first appeared in 1904, and has been deservedly popular. The photographic illustrations have never been excelled, and there is plenty of sound natural history in the often rather quaint colloquy between the cock robin and his precocious chicks, who persist in asking about migration and that sort of thing. We wish to record—for what it is worth—the opinion of some young readers that they like to listen to Mr. Kearton and to the robin, but not to the two at once.

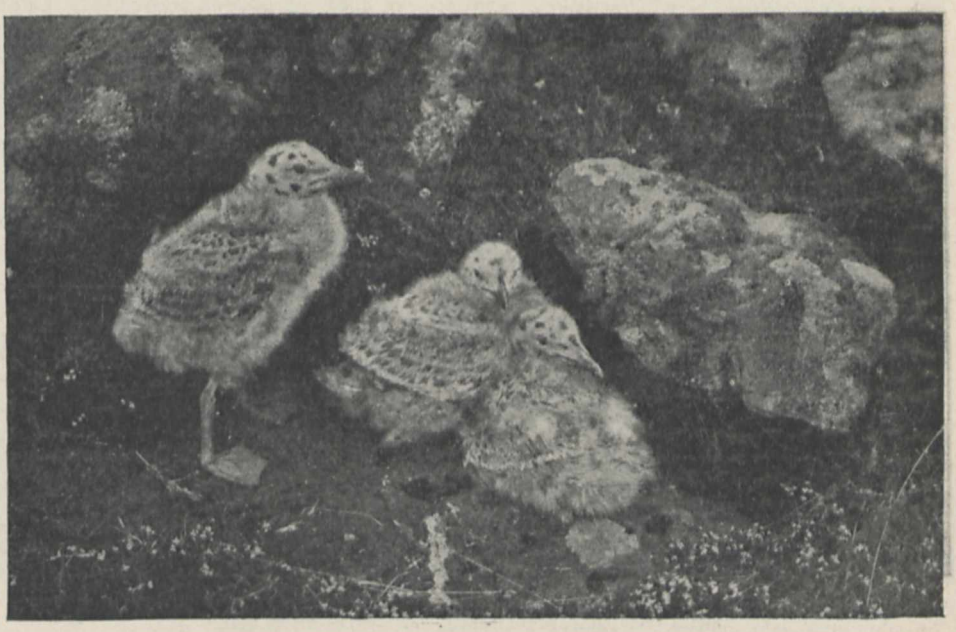


FIG. 1.—Young Great Black-backed Gulls. From "The Adventures of Cock Robin and his Mate."

(3) Mr. Snell apologises for his study of the common objects of the country, but there is no need for apology. His unpretentious descriptions are direct and appreciative, his photographic illustrations are beautiful and with ideas behind them, and the whole book has an open-air feeling about it. In connection with "Nature-Study" in schools, this book will be of service in showing the beauty and interest of common things. Mr. Snell begins with a study of the so-called sleep of plants, and shows us anemones and wood-sorrel and goatsbeard open and closed, and the sweet-scented evening campion conspicuous in the dim light. Another study deals with protective coloration, and is illustrated, for instance, by admirable photographs of the eggs of the ringed plover among the stones on the beach, and of the lappet-moth, so like a crumpled, withered leaf. The author has an interesting note on the way animals squat in conspicuous places when they are away from their usual surroundings, and he doubts if birds often catch butterflies in flight; but this useful scepticism might have been extended with advantage to some of the author's own sentences, *e.g.* that which points out the boulder-like appearance of the "half-wild mountain sheep" of Wales and Scotland. Are these the *moutons sauvages* which the French visitor slew in default of deer? There are admirable studies of the sundew, of the life-history of the frog, of the beautiful forms of fungi, and of clouds, all with fine illustrations. Very interesting is the series of photographs taken in the woods at night—of moths feeding, of woodlice on the tree trunk, of slug and frog, and so on. The value of the book is increased by the practical directions given in connection with some of the more difficult photographs, for no one can look at them without wishing to be able to attain to similar success in recording observations.

(4) Cassell's "Nature-Book" is probably the most beautiful of the many volumes already called into existence by the increased interest which is being taken in open-air natural history. It is lavishly illustrated with charming photographs and coloured pictures, and even to turn over its pages is a great pleasure. Yet, in the strict sense, it is not a book, having neither unity nor continuity. It is made up of such delightful parts, by many different authors, that we cannot but regret that they do not form a

[1] (1) "Last Hours with Nature." By Eliza Brightwen. Edited by W. H. Chesson. Pp. 223; illustrated. (London: T. Fisher Unwin, 1908.) Price 2*s.* 6*d.* net.

(2) "The Adventures of Cock Robin and his Mate." By R. Kearton. With upwards of 120 illustrations from photographs taken direct from nature by Cherry and Richard Kearton. Pp. xvi+240. (London: Cassell and Co., Ltd., 1908.) Price 3*s.* 6*d.*

(3) "Nature Studies by Night and Day." By F. C. Snell. Pp. 319; illustrated. (London: T. Fisher Unwin, 1908.) Price 5*s.*

(4) "The Nature-Book. I. A Popular Description by Pen and Camera of the Delights and Beauties of the Open Air." Pp. iv+372; 13 plates, 12 coloured, and numerous illustrations. (London: Cassell and Co., Ltd., 1908.) Price 12*s.* net.

(5) "The Story of the Sea and Seashore." By W. Percival Westell. Pp. 343; illustrations from photographs and drawings (the latter mostly by C. F. Newall) and 8 coloured plates (7 by W. S. Berridge and 1 by C. F. Newall). (London: Robert Culley, n.d.) Price 5*s.* net.

(6) "The House in the Water; a Book of Animal Life." By Charles G. D. Roberts. Pp. 323; with 18 full-page plates. (London: Ward, Lock and Co., Ltd., 1908.) Price 6*s.*

(7) "Close to Nature's Heart." By William M'Conachie. Pp. x+276. (Edinburgh and London: William Blackwood and Sons, 1908.)

whole. The book gives useful samples of profitable nature-studies, *e.g.* of a river or of a wasp nest, but more should have been made of the remarkably fine collection of illustrations. We may also point out that there is an unpleasant smack in some of the much too ambitious titles—"How to know the Insects," and so on.

(5) Mr. Westell's guide to the natural history of the sea and seashore contains much interesting information, somewhat carelessly stated, and many of the illustrations are very fine. In many cases the coloured plates do not show the natural colours, and the text contains many errors. It is a pity to speak of the "bones of starfish," of the Bass Rock as a "remarkable headland," of Luidia as "one of the largest British brittle-stars," of Polycystina as "shell-fish." Mr. Westell refers frequently and gratefully to Miss Newbigin's admirable "Life by the Seashore," but the fact that he never spells her name correctly is a trivial illustration of the carelessness which disfigures his book.

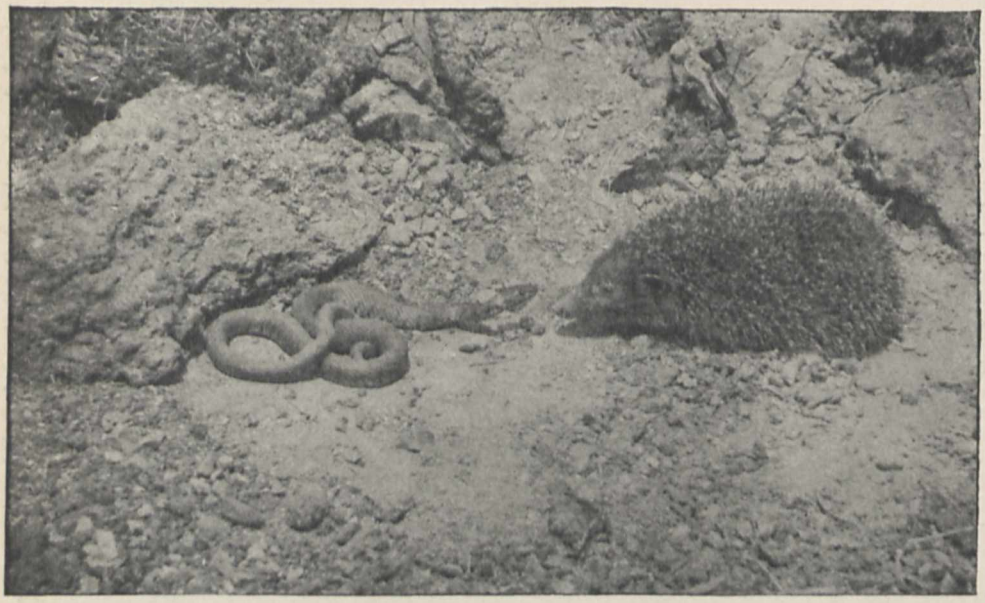


FIG. 2.—Hedgehog and Grass-snake. From "The Nature Book."

(6) Mr. Charles G. D. Roberts writes a picturesque book about beavers, bears, wolves, moose and other Canadian animals, and tells a good story. There is convincing work in his nature-studies, and "From the Teeth of the Tide" is uncommonly well done. It is unlikely that the author meant his tales to be included under the serious rubric of "nature-study," but they may help some to get away from the fallacious automatic-machine theory of the creature.

(7) What are the ends of nature-study, for they are many? We are told that this discipline—which is now part of the day's work of the elementary school—"implies an appreciative outlook upon the whole environment, and that not from a scientific view-point only, but from the æsthetic and practical as well." Thus among the aids to nature-study which have sprung up on demand with almost magical quickness, some emphasise precise observation and others graphic registering; some the cultivation of the school garden, and others the culture of the scientific mood; and all this is well if it be well done. But that there is something more than all this a book like Mr. M'Conachie's reminds us, for it expresses an end of nature-study which, if attained, covers a multitude of sins, but without which the naturalist with his lynx eye is a fingering slave, and the school garden only an open-air laboratory. That end is the love of the country, which is to be felt, not spoken about. Mr. M'Conachie does not speak of it, except, perhaps, in the repellent title of his book, which is congruent, however, with his vocation, but his pictures, which are worthy of a place beside those of Jefferies and Burroughs, reveal it eloquently. He knows his birds and his flowers not as species so much as familiar friends; he takes us, not on botanical excursions, but for a walk in the country, and we return wondering whether it was poet or naturalist who led us. *Nur was du fühlst das ist dein Eigenthum*, and no one can read these sketches—such as the coming of spring, the promise of summer, the turn of the year, and December days—without feeling that the author has made the natural history of the year his own in the truest sense. Many of the sketches are local; but though we have never been very near the Scotch parish which contains the quarry pool, the brook path, the mill stream, the haunt of the pike, and the old forest that we now know, there is so much of the universal in the pictures that we seem to have known and loved them for many years. To all who would know the true inwardness of nature-study we commend this book. J. A. T.

LIEUT. SHACKLETON'S ANTARCTIC EXPEDITION.

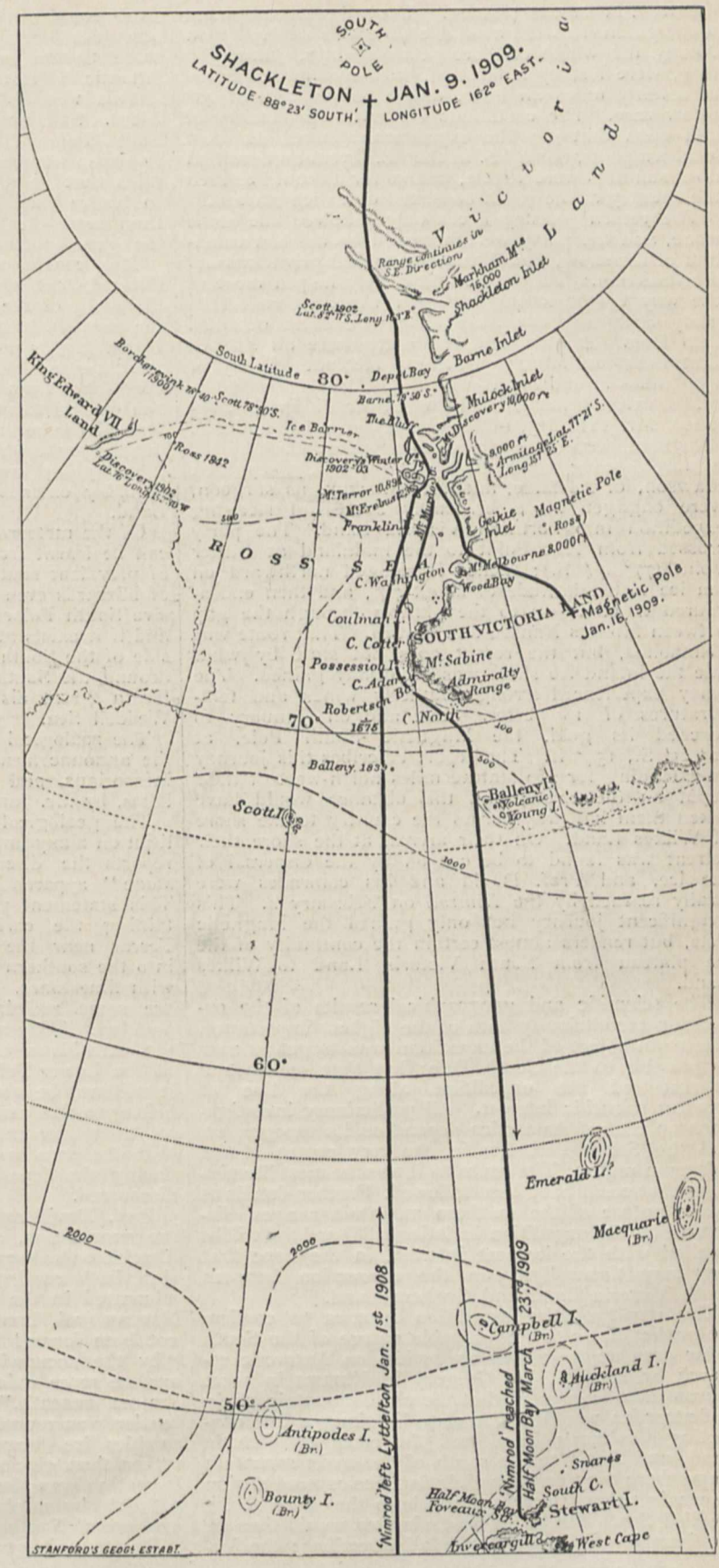
(1) EXPLORATIONS AND RESULTS.

THE anxiety occasioned by the delay in the return of Lieut. Shackleton's expedition has been relieved by its safe arrival and the news of its supreme success. A cable published in the *Daily Mail* of March 24 records the magnificent exploits of the expedition, and though there are occasional obvious verbal inaccuracies in regard to some technical points, the report makes clear the main outlines of its great achievements. They unquestionably place it in the front rank of Polar expeditions. Its two most striking achievements were the sledge journeys by which Lieut. Shackleton reached within one hundred geographical miles of the South Pole, and discovered the nature of the very centre of the South Polar region, and by which Prof. David gained the magnetic south pole, and rendered almost certain the continuity of South Victoria Land and Wilkes Land.

The expedition was landed early in 1908 near the

former winter quarters of the *Discovery* on MacMurdo Sound, and there established its main base. It gained its first success by the ascent of Mount Erebus (13,120 feet high), and the discovery of its old crater at the height of 11,000 feet. During the winter depôts were established in readiness for the summer journeys, and in this work the motor-car proved of great service over the sea ice, though it could not be used on the land ice or on the Barrier.

The southern sledging party—Lieut. Shackleton, Lieut. Adams, Mr. Marshall, the surgeon, and Mr. Frank Wild—left Hut Point on November 3, 1908. On November 5 the explorers were stopped by a blizzard, which delayed them for four days; thanks to their pony sledges progress southward was rapid, and on November 13 they reached a depôt previously formed at latitude 79° 36′. The route selected was along the meridian of 168° E., to the east of that followed by Capt. Scott's party. The Ice Barrier proved to have an undulating surface, and from the brief reports much of the upper part of it appears to be composed of snow. The previous southern record was passed on November 26, and about eighty miles further south the Great Ice Barrier appeared to end as "the ridges of snow and ice turned into land." At this point, 83° 33′ S. and 172° E., Lieut. Shackleton began the ascent of a great glacier, which was so crevassed that on December 6 the party only advanced 600 yards in the one day. It may therefore be inferred that progress to the south was blocked by the mountains on the eastern margin of South Victoria Land bending round to the east, and, judging from the crevassed nature of the ice, the face of the plateau is very steep. On December 8 the air was clear, and some new mountains were discovered trending southward and south-westward. The glacier by which the route on to the ice plateau was achieved appears to have been badly crevassed throughout, and it took twelve days to reach an altitude of 6800 feet. Everything that could be spared was left behind in a depôt at 85° 10′ S., and on reduced rations the party struck southward toward the Pole, forcing their way against southern blizzards. Eight days' march over undulating, and apparently in places very broken, ice led to the summit of the plateau at the height of 10,500 feet. The mountains had disappeared in the distance by December 27, so probably they were a mountain range striking westward from those along



the margin of the plateau. Once again equipment was lightened as the available time was nearly spent. Nearly the whole of three precious days, January 7 to 9, were lost by a blizzard, with a wind estimated at seventy miles an hour, and a temperature of 40° below zero. The conditions improved on January 9, and upon that day the expedition attained its most southern point, 88° 23′ S. in 162° E. From that position no mountains were visible, and so far as could be seen the country to the south consisted of an ice plateau.

The return journey necessarily followed the same route, and the party were harassed by the bad condition of the snow, and illness due to their privations and over-exertion. They were fortunately helped most of the way by the strong southern wind. Two of the party collapsed, but Shackleton and Wild obtained help from the ship, and the party were all safe at Hut Point on March 4, after a brilliant journey of 1708 miles in 126 days.

Meanwhile a party consisting of Sir Philip Brocklehurst, Mr. Priestley, of Bristol, a geologist, and Mr. Armytage, were at work in the neighbourhood of the Ferrar Glacier; while Prof. David, of Sydney, Mr. Mawson, of Adelaide, and Mr. Mackay, as surgeon, were engaged on a brilliantly successful sledging expedition into northern Victoria Land. The party crossed from Hut Point to the mainland at Butter Point (77° 40′ S.); thence it sledged northward on sea ice to the latitude of about 75°, and then endeavoured to climb on to the plateau through the gap between Mounts Nansen and Larsen. That route was abandoned, but the report does not state by what line the inland ice sheet was eventually gained. The party experienced strong southerly winds and temperatures of 18° below zero, and on January 16 reached its goal, the Magnetic South Pole, at 72° 25′ S., 154° E. The report describes this journey as extending for 260 statute miles north-west of their depôt on the coast; and this distance would have taken them half-way across the country to the shore of Wilkes Land. On their arrival at the shore their retreat was found to be cut off by the dispersal of the ice, and Prof. David and his comrades were finally rescued by the *Nimrod* on February 4. This magnificent journey not only gained the Magnetic Pole, but renders almost certain the continuity of the ice plateau from South Victoria Land to Wilkes Land.

The scientific and geographical results of the expedition are obviously both of the highest importance. The main object of the expedition was to get as near as possible to the South Pole; but that sentimental interest led the expedition along the line of greatest scientific interest. All preliminary investigations on central Antarctica depend on its topography, and the South Pole lies in the very centre of the unknown region. The route to it was the most illuminating that could have been followed. Further details as to the nature of the southern mountain ranges discovered by the expedition in latitude 86° and 87° will be awaited with the keenest interest, in the hope that they may throw light on the connection between South Victoria Land and Graham Land.

The result of the expedition appears to confirm the prediction as to the probable nature of the South Polar area suggested in an article on Antarctic research by Prof. J. W. Gregory in NATURE in 1901. It was there suggested that the chief mountain chain in Antarctica would be found to lie along a line connecting Graham's Land and the coast of Victoria Land, and that "to the south of the main mountain range there may be an undulating, ice-covered region descending slowly across the Pole to the shore of the Weddell Sea. The main ice-drainages would then be not from the Pole radially in all directions; the ice-shed would run along the Pacific shore with a short, steep northern face and a long, gradual slope southward to the Pole and across it northward to the Atlantic" (NATURE, vol. lxiii., 1901, p. 612).

This view is now apparently fully confirmed by Lieut. Shackleton's report that the geographical South Pole "is doubtless situated on a plateau ten to eleven thousand feet above sea-level." The mountains that he discovered range from three thousand to twelve thousand feet in height, so though lower than some of the peaks in northern Victoria Land, the great altitude of the plateau is maintained.

This conclusion as to the structure of the South Polar district had been regarded as so probable from the work of the National Antarctic Expedition that the north-western sledging expedition under Prof. David throws perhaps equally important light on the structure of Antarctica. For the journey 260 miles north-west from their depôt on the shore of the Ross Sea carried them almost into Wilkes Land. The altitude of the southern magnetic pole is not stated, but judging by the distances marched, most of the route probably lay over an undulating ice plateau, which probably extends northward to the coast of Wilkes Land.

Of the meteorological results the most striking that can be learnt from the cable is the wide distribution of prevalent southerly winds, blowing with the force of blizzards even to the farthest south. So that elusive South Polar anticyclone has not yet been found, and if it exists at all must be situated on the Atlantic side of the South Pole. If so, the ice-covered plateau around the South Pole may keep at a high altitude for a great distance from the Pole towards the Weddell Sea.

The zoological results are said to be valuable, and the announcement of the collection of many rotifers, infusorians, and other organisms in the freshwater lakes, by Mr. James Murray, is of particular interest.

The geological results may be expected to throw light on many important problems. Lieut. Shackleton reports the discovery of "Coal-measures in limestone" apparently among his southern mountains. This statement probably means that the rocks containing the carbonaceous material found by Mr. Ferrar near the *Discovery* winter quarters extend into the southern mountains, and are there associated with limestones. The only definite fossils referred to are some radiolaria discovered by Prof. David in boulders. They may be of any age, but, considering the resemblance of the slates of Cape Adare to those of the Lower Palæozoic rocks of southern Australia, it will not be surprising if these radiolaria prove to belong to that series. As no other fossils are referred to, their absence, or at least their rarity, suggests that the area was under severe climatic conditions during the deposition of all the sedimentary rocks discovered.

Prof. David reports that the chief Antarctic bergs are snow-bergs, and this announcement and Lieut. Shackleton's description of the nature of the ice barrier both confirm the conclusion as to its origin advocated in the review of Captain Scott's book in NATURE (vol. lxxvii., p. 298), viz. that this ice had not been formed from the glaciers but from sea ice "by the accumulation of layers of snow upon the surface more quickly than the ice was dissolved by the sea beneath." A photograph of the face of the barrier was reproduced to show that its material resembles ice formed from cemented stratified snow rather than glacier ice. The method of its probable formation was also illustrated in NATURE (vol. lxxvii., p. 561) by a photograph from the report on the geology of South Victoria Land.

The tectonic geography of Victoria Land, we may

now expect, will be conclusively settled, as the expedition fortunately had with it Prof. Edgeworth David, of Sydney, who determined the monoclinal structure of eastern New South Wales. The first geological information regarding South Victoria Land announced by the *Discovery* suggested that the country was a typical representative of the Pacific coast type; but this conclusion has been regarded as improbable by Dr. Prior and Herr Emil Philippi on petrographic grounds. But that evidence will not give the final test, and the data collected by the National Antarctic Expedition render it probable that the coast of South Victoria Land is of the sub-Pacific type, agreeing essentially with that of the eastern coast of Australia. As the greatest authority on the geology of that coast was a member of the expedition, he may be trusted to give this question its final solution.

The expedition is a great triumph for Lieut. Shackleton. The greatness of his results is not merely due to the distance by which he surpassed previous southern records, but to his having, in the far south, left the low-level ice and climbed on to the plateau and discovered its nature in close proximity to the Pole. He would probably have added little further of scientific value by going another one hundred miles southward, for he no doubt saw enough to justify his belief that the ice plateau continued across and beyond the Pole. The results of his journey show him to be a great leader as well as a bold pioneer. He inspired his colleagues with implicit confidence, and the rich harvest secured in one short season's work is due not only to his energy and personal courage, but to his full use of the capacities of every member of his staff. He had the nerve as a commander to run great risks by scattering his forces, and the judgment that enabled him to avoid disaster. The messages of congratulation which have been sent to him by the King and Queen, the Royal Society, and the Royal Geographical Society, represent the warm feeling of national pride and satisfaction at the remarkable achievements of the expedition.

(2) THE SOUTH MAGNETIC POLE.

The position obtained by the Shackleton expedition for the south magnetic pole is lat. 72° 25′ S., long. 154° E. It may be of interest to compare the position thus indicated with earlier results. The first observational data enabling an approximate position to be assigned were those obtained by Sir J. Ross about sixty-five years ago. General Sabine's Antarctic declination chart based on these observations places the pole at about 73½° S., 147½° E. In chart vi. attached to vol. ii. of Prof. J. C. Adams's "Collected Papers," the position deduced from Ross's data is about 73° 40′ S., 147° 7′ E. The next observational data are those of the *Southern Cross* expedition of 1898–1900, consisting of dip observations made by the magnetic observer, Mr. L. C. Bernacchi. In the discussion of these by Mr. Bernacchi and the present writer the approximate position deduced for the Pole at the epoch 1900 was 72° 40′ S., 152° 30′ E. The National Antarctic Expedition of 1901–4 provided a much more copious series of observations. The dip and the declination observations, treated independently by Commanders L. W. P. Chetwynd, R.N., and F. Creagh-Osborne, R.N., gave almost identical positions, the mean finally accepted[1] being 72° 51′ S., 156° 25′ E. The position of the pole undergoes presumably slow secular change, and unless the regular diurnal and the irregular changes of terrestrial magnetism in its immediate neighbourhood are totally different in character and size from those a few hundred miles away—an unlikely contingency—there is probably a more or less regular diurnal change of position, in which the pole (if defined as the spot where the dipping needle is vertical) describes an oval curve several miles in diameter. Superposed on this are doubtless irregular excursions, which may occasionally be of much larger amplitude. Owing to the low directive force on the compass needle, and the extent to which it is affected near a magnetic pole by irregular disturbances, the members of the expedition were probably well advised in using a dip circle, especially if they observed in two perpendicular planes, so as to get rid of the uncertainty in the position of the magnetic meridian. Magneticians will await with interest a detailed account of the method of observation adopted, and the exact nature of the results obtained.

C. CHREE.

[1] National Antarctic Expedition, 1901–4. Physical Observations, p. 156.

(3) METEOROLOGICAL OBSERVATIONS.

The information available in the summary of the results of Lieut. Shackleton's expedition does not enable us to go much further into the interesting question of the Antarctic anticyclone, but it is noteworthy that Lieut. Shackleton, like Capt. Scott in his journey to the south, experienced strong and persistent southerly winds. From the time he reached the plateau at an altitude of about 10,000 feet on December 26 until the return to the ship we find constant mention of a "southerly blizzard," the wind behind the party greatly facilitating the return journey. From the observations of temperature, which must, of course, be scanty until sufficient time has elapsed for mails to be received, it would appear as though the surface temperature on the barrier ice and that on the high plateau were not very different, notwithstanding the difference of 10,000 feet in the altitude. In ordinary climates this difference means a fall of 33° F. in the temperature. On reaching the summit the temperature ranged from −5° to −38°. The blizzard which detained the party during January 7, 8, and 9 had a temperature of −40° (rather a different kind of thing, probably, from the so-called English blizzards of which we have heard so much of late). On the barrier-ice temperatures of −18° and −35° F. are given, so that the conditions do not seem to have been more severe at the greater altitude. In the Alps, and the rule is probably general, a small vertical temperature gradient is associated with anticyclonic conditions; if full information, when it is received, bears out this inference of the slight or non-existent fall of temperature with height, it will go far to establish the belief in an Antarctic anticyclone.

But the persistent southerly winds are hard to explain, though we can hardly now doubt their existence on the western part of the great ice barrier. On the slope to the southward they may be due to the same causes that make a wind blow down a valley at night, and on the barrier ice, as Mr. R. H. Curtis has stated, an east or south-east wind may be deflected into a south wind by the range of mountains to the westward. On the plateau neither explanation will serve. It is just possible that the south is not the prevailing wind there, since a month is not long enough to show the prevailing direction.

Probably the blizzards of these regions are extremely shallow, for it was noted during the expedition of Capt. Scott that the motion of the barometer was of very little use in foretelling the weather, and the winds, therefore, cannot be of the same character as those to which we are accustomed.

Lieut. Shackleton and his companions are certainly to be congratulated on the excellent results they have achieved, and on their safe return. Many Arctic and Antarctic expeditions have shown that, apart

from scurvy, which can now be avoided, extreme cold is not unfavourable to health, but the magnitude of the results and the absence of serious accidents in the face of such difficulties are beyond all praise.

W. H. DINES.

(4) BIOLOGICAL RESULTS.

As regards the biological results of Lieut. Shackleton's achievement, little can be inferred from the tantalisingly brief statements made in the telegrams. That there will be news of great interest is certain, for Mr. James Murray, whose skill and perseverance as an investigator were proved in the course of the Scottish Lake Survey, is not one to have failed in making the most of his unique opportunity. There is biological as well as geological interest in the report—rich deposits of foraminiferal mud (with abundant Biloculina) 40 feet above sea-level, of radiolarian remains in the erratic chert boulders at Cape Royds, and of Coal measures in latitude 85°, with seams of coal 1 foot to 7 feet thick. The frozen fresh-water lakes near Cape Royds contained large sheets of a "fungus-like plant" and abundant diatoms. Many lichens were found and a few mosses. Mr. Murray found abundant infusorians, rotifers, and water-bears (Tardigrada) in the fresh-water lakes, and demonstrated afresh the strong resistance which rotifers have to extremes of temperature. It is well known that many rotifers may survive very thorough desiccation, and that some are able to resist deprivation of air in an ordinary air-pump vacuum. Zelinka showed that Callidina can revive after exposure to −20° C. and immersion in hot water at 70° C.; it will be interesting to hear what fresh instances of plasticity are afforded by Mr. Murray's researches on the microscopic fauna of these polar lakes. One of the despatches says that numbers of rotifers which had been frozen into ice for three years revived after a few minutes' thawing, and began eagerly devouring the fungus that abounds in the lakes. What is probably an unauthorised addendum to the original telegraph credits Mr. Murray with discovering that the southern rotifers are peculiar in being viviparous, but viviparous species of rotifers have been known for a long time. Another crumb of biological information is the report of the ringed penguin at Cape Royds, which extends the record of the southerly range of this bird. The only other crumb requires a grain of salt, for it tells us that the marine fauna near Cape Royds resembles the Carboniferous fauna of Australia.

THE SOLAR RESEARCH UNION.[1]

THE first volume of Transactions, at the first and second conferences, of this International Union has already been noticed in NATURE (vol. lxxv., p. 458).

The present publication concerns itself with the proceedings of the third conference, held at Meudon on May 20–23, 1907, together with reports of various committees of the union, and some original papers which have not appeared previously in an accessible form. As in the case of the first volume, the general editorship has been in the capable hands of Prof. Schuster, chairman of the executive committee.

Of the six parts into which the book is divided the first two consist simply of lists of the scientific bodies constituting the union, delegates present, and men of science invited to take part. The third section, thanks to the excellent record kept by the three secretaries, gives full minutes of the six meetings held during the conference.

The first action of the delegates was to elect as president, by acclamation, M. Janssen, the venerable and illustrious director of the Observatory of Meudon, whose subsequent death has been universally mourned. His short speech, accepting office and returning thanks, was concluded by the following words:—"C'est à vous, Messieurs, que je confie l'avenir de cette science du soleil que j'ai cultivée avec passion pendant plus de quarante années, de cette science des mondes dont j'entrevois l'avenir fructueux. Laissez-moi vous remercier, au moment où je termine ma carrière, de la joie que vous me donnez aujourd'hui."

Mutual helpfulness and coordination, with due regard to the disparity among the equipments involved, might be regarded as the watchwords of the conference. The necessity for these in the spectroscopic determination of the solar rotation periods and in the observation and classification of solar prominences was urged by various members.

M. Perot presented a new measure of the red cadmium line for use as a primary standard, made by MM. Benoît, Fabry, and himself, while the committee on standards of wave-length was given, by resolution, the further duty of preparing a list of secondary standards, to be submitted to the constituent societies, and, if approved by them, adopted by the Union. Both the paper on the red line of cadmium and a further paper by MM. Fabry and Buisson, on the measurement of wave-lengths for the establishment of a system of standard lines, are printed in full.

A complete account of the scheme of sun-spot spectrum observations, suggested by the committee on sun-spot spectra and drawn up by Prof. Fowler, was adopted by the Union, and is incorporated in the Transactions. This scheme allots to each observer a section of the spectrum of about 250 tenth-metres, together with certain other observations outside the special region, but is far from discouraging the initiative of the individual in undertaking further work when opportunity presents itself. The whole of the visible spectrum, in overlapping sections, is already portioned out among the observers available. Though almost without doubt the future of this subject lies with the photographic method, it is a wise policy to make use of the equipments already existing and of the observers already trained in visual observations of spot spectra for a more complete and co-ordinated study than has yet been undertaken. The further knowledge gained will be a welcome endowment for the large sun-spot spectrographs when they are more plentiful than at present.

With regard to the solar constant, resolutions were adopted stating the need for central stations where instruments for this work might be tested and standardised, and indicating the laboratory of M. Ångström at the University of Upsala as the principal central station. A report of the work carried out in the Smithsonian Astrophysical Observatory, relative to the solar constant, is also printed.

The report of the committee on work with the spectroheliograph gives the general programme of observations suggested to the individuals and institutions cooperating in this important work. The need for mutual help, in the interest of progress, is particularly great in work of this character. For intimate study of the rapidly changing solar activities a series of photographs taken as closely together in time as possible is desirable. With a ring of stations round the globe the records at the more westerly would be in sequence after the more easterly, and thus in any one day a series of photographs would

[1] "Transactions of the International Union for Cooperation in Solar Research." Vol. ii. (Third Conference.) Pp. viii+244. (Manchester: University Press, 1908.) Price 7*s.* 6*d.* net.

be available on which to trace changes. The present distribution of contributing stations, India, western Europe, and America, fulfils in some sort this need, though a distinct lacuna exists in the longitude of Australia.

A paper, by Prof. Hale, on the measurement of spectroheliograms gave rise to an interesting discussion concerning the methods of reducing the photographs already obtained. In his case, after some experiments, a photometric method of determining the areas of selected flocculi had given satisfactory accord, while Sir Norman Lockyer was able to report that, in the direct measurement of the series of spectroheliograms being formed at South Kensington, and in spite of the difficulties, good agreement was obtained by the two observers engaged in the work. In the study of the relation between solar activities and terrestrial changes, measurements of the numbers and areas of flocculi are likely to be of great importance. At all times the areas affected are greatly in excess of the spotted areas, while during the almost spotless periods of sun-spot minima, flocculi persist (in lessened degree), and bridge what would be otherwise practically a gap in the records.

The computing bureau of the union, established at Oxford under Prof. Turner, will make special studies of such spectroheliograph negatives as are entrusted to it by members: this, however, without prejudice to the right of reducing and studying photographs by those responsible for their taking. A start has already been made at Oxford on some plates lent by Prof. Hale.

The difficulties in the selection of the flocculi, recorded on the plates, for measurement, together with differences in size and quality of the photographs, make satisfactory and comparable measures far from easy. Great credit is due to the institutions and workers on this subject for the progress already made.

A proposition by Sir Norman Lockyer supporting the project for the establishment of a solar physics observatory in Australia was carried unanimously. This project, if carried into effect, would add another link to the chain of spectroheliographs girdling the earth.

An account, by M. Deslandres, of the spectroheliograph equipment and work accomplished with it at Meudon, together with an excellent picture of the sun in K_2 light, and a series of spectra in the neighbourhood of K used for the determination of the radial velocities involved in the solar activities, concludes the volume.

The delegates were invited by Prof. Hale to come to California for the next meeting, so that the date 1910 and the place Mount Wilson were provisionally decided upon, Prof. Hale being thanked for his kind invitation.

The publishers are to be congratulated on the get-up of the book, the paper and printing being good and the binding neat and effective.

T. F. C.

THE MANUFACTURE OF BASIC STEEL.

OF the many varieties of cast- or pig-iron, the three following percentage compositions may be taken as representing three most important types:—

	(*a*)	(*b*)	(*c*)
Carbon	3·5	3·5	3·5
Silicon	2·5	1·0	2·5
Manganese ...	0·5	2·0	0·6
Sulphur	0·05	0·06	0·04
Phosphorus ...	0·05	2·0	1·6

An average chemical specification with regard to sulphur and phosphorus in steel is "not to exceed 0·06 per cent. of each." For certain Government work the standard is 0·04, and easier specifications allow of 0·08, but 0·06 is a fair average.

The first pig (*a*) is suitable for conversion into steel by the acid process, in which the oxidising agent, whether oxygen of the air or oxygen from oxide of iron, acts upon the metal while it is contained in a vessel or a hearth composed mainly of the acid material silica. In this process the slag is necessarily of an acid nature, and sulphur and phosphorus therefore are not eliminated. Enormous quantities of iron ore are available, which contain very much higher proportions of phosphate than the hæmatite from which the cast iron of the (*a*) variety is produced, and as in the blast furnace practically all the phosphorus in the charge of ore, fuel, and flux enters into the metal, pig-irons are made that are much too high in phosphorus for conversion into steel by the acid process. By using a vessel or a hearth lined with basic material, such as burnt dolomite or magnesia, the steel can be finished in contact with a slag sufficiently basic to effect the removal of the phosphorus. The basic process as commonly worked some years ago, and sometimes even to-day, consisted in charging a mixture of about equal parts of pig-iron and scrap on a basic hearth, and then, by additions of iron ore and lime, eliminating the silicon and manganese, as well as the carbon and the phosphorus, to the extent necessary in the manufacture of mild steel. By this ordinary method of working, as the phosphorus is only sufficiently eliminated when the carbon is low, the process was generally used for the manufacture of mild steels, as unless the highly phosphoric slag is removed from the surface of the metal at the end, during re-carburisation phosphorus is reduced from the slag, resulting in an increased percentage of phosphorus in the bath. Sulphur is not to any great extent removed during the process as ordinarily conducted, and although the amount of sulphur in the bath can be reduced by additions of fluor-spar during the conduct of the process, these additions, if in excess, not only prove destructive to the banks of the basin-shaped receptacle, but render the phosphate in the slag insoluble, and thus decrease its value for agricultural purposes.

The pig-iron for the basic process must therefore be comparatively low in sulphur for successful regular working, and if by any means it should be high in sulphur must be subjected to a desulphurising process, such as the Massenez manganese process or the Saniter oxychloride or fluoride process.

The ordinary conditions for the manufacture in the blast furnace of pig-iron high in silicon content are those favourable to the production of a pig-iron low in sulphur, but a high-silicon pig-iron used in the ordinary basic process is again destructive to the banks of the furnace. The manufacture of a low-silicon low-sulphur pig, such as (*b*), can be effected by the use of manganiferous ores added to the blast-furnace charge. These ores are expensive, and the manganese in the pig-iron is lost during the conversion of the pig into steel. These statements give shortly the conditions connected with the manufacture of basic steel.

Many attempts have been made to improve the ordinary method of working, either from the point of view of being able to accept pig-iron high in sulphur, or, on the other hand, of being able to use a pig-iron high in silicon, because of the difficulty and expense connected with making the pig low in silicon and sulphur.

In 1894 a patent was granted to Messrs. Bertrand and Thiel for removing the silicon, the bulk of the phosphorus, and part of the carbon and manganese in

one basic furnace and then transferring the metal, but not the slag, to a second furnace, completing the purification and finishing the steel in the second furnace. The slag of the primary furnace is valuable, and the removal of the phosphorus before the carbon is a great advantage. This process has met with considerable success. In 1898 Talbot introduced his continuous process, which is so well known that it need hardly be described.

In 1900 Monell patented a process which has come into considerable public prominence owing to a recently decided law case with regard to its alleged infringement. In certain circumstances the amount of scrap required for the ordinary working of the basic open-hearth process is not easily obtained, and although by the ordinary process an all-pig charge may be successfully worked, the time occupied in getting rid of the large quantity of impurities increases the length of time necessary for purification, and hence decreases the output of a furnace of a given size. Monell charges on to the bottom of the open-hearth the usual quantity of limestone which was employed in a furnace of like capacity with charges of half pig and half scrap. But along with this limestone he charges an amount of oxide of iron, generally in the form of iron ore, equal to about 20 per cent. of the weight of the pig-iron it is proposed to treat. These materials are heated to a red heat, and whilst still unfused the charge of pig-iron in the molten condition, either direct from the blast furnace or from a metal mixer, is poured into the furnace as rapidly as possible. This causes an active reaction, and the materials being at a comparatively low temperature the ore oxidises the phosphorus, silicon, and manganese in the pig-iron with extreme rapidity, and at the same time oxidises a portion of the carbon.

If the phosphorus in the original pig be not more than 0·80 per cent., in about one hour it will be reduced to less than 0·1 per cent., the carbon remaining being about 2 per cent. Eighty per cent. of the slag is now removed, leaving the metal only very thinly covered, and then oxide of iron is added to the bath and the carbon gradually reduced to the percentage required; so that by this means, in the basic furnace, a steel sufficiently low in sulphur and phosphorus is produced, and of any carbon desired, without the necessity of going down to a very low percentage of carbon, as in the ordinary process, and either being content to make only mild steel or to make special arrangements for carburising after removal of the slag (the Darby process). The yield by the Monell process is more than 100 per cent. of the metallic charge, owing to reduction of iron from the ore, the mean of about eighty consecutive trial heats being 108 per cent., but this is a feature not peculiar to this modification only. Unfortunately for the usefulness of the Monell process in this country, when the pig-iron contains from 1·5 per cent. to 2·0 per cent. phosphorus, as only about 80 to 90 per cent. of the total phosphorus is removed, too much remains in the metal at the end of the reaction to make the process valuable, and after the removal of the first slag, additions of lime and ore must be made as in ordinary working.

Improvements made in the basic process even since 1900 have rendered the application of the Monell process unnecessary in this country. Metal mixers, large vessels in which molten iron from the blast furnace is stored, were originally used mainly to obtain a more regular composition of iron for either the converter or the open-hearth process. Gradually these have developed in size from a capacity of about 70 or 80 tons up to the present day, when mixers of 200 to 600 tons capacity are used, and the metal-mixer is now often gas-fired, so that the heat of the metal can be maintained for longer periods, and even cold pig-iron can be added. The metal mixer is now much used as a furnace for the preliminary purification of the molten cast-iron from the blast furnace. The modern metal mixers are lined with dolomite or magnesia, are gas heated, oxides of iron are added to the contents, and the blast-furnace metal made and cast into pigs during week-ends, and generally called week-end metal, can be melted in them. At the comparatively low temperature maintained in the mixers (about 1500° C.) silicon and phosphorus are partially eliminated, whilst the carbon is but little affected. The sulphur is decreased because of the length of time the metal is lying in a molten condition in the mixer, during which the manganese sulphide gradually floats to the top and is removed with the slag. The resulting metal is in good condition, and of suitable composition to be transferred to the ordinary basic open-hearth furnace and finished with a comparatively clean slag —that is, a slag not rich in phosphate.

From the results given by Mr. A. Windsor Richards in a paper to the Iron and Steel Institute recently, it would seem as if the basic Bessemer process had received, through the modification in its working designed by Dr. Massenez, an efficient tonic in its desperate struggle with the open-hearth process. By this modification the ordinary high-silicon low-sulphur Cleveland pig (*c*), made from native ores, is poured in a molten condition into a basic lined converter, into which has been previously placed iron ore, with a small quantity of lime. The blow is continued until the carbon flame appears and all the silicon is oxidised, when the converter is turned down and the slag is carefully removed, this slag containing 35 to 45 per cent. silica and practically no phosphate. The linings are not affected because of the short time during which this slag is acting, and also because of the comparatively low temperature. The charge is then finally blown in the ordinary way, giving a slag containing 14 to 20 per cent. of phosphoric anhydride, 95 per cent. of which is in the soluble condition. The addition of oxide distinctly improves the yield, and the process is said to be working thoroughly successfully. Week-end metal is cast into pig beds and put on the market for foundry purposes, which cannot be done with basic pig (*b*), as it is only suitable for conversion into steel by the basic process.

A. McW.

NOTES.

PROF. T. G. BONNEY, F.R.S., will be the president of the British Association at the meeting to be held at Sheffield next year.

WE have to announce, with deep regret, that Dr. Arthur Gamgee, F.R.S., emeritus professor of physiology, University of Manchester, and late Fullerian professor of physiology in the Royal Institution, died in Paris on Monday, March 29, at sixty-seven years of age.

THE Anthropological Society of Paris will celebrate the jubilee of its foundation on July 7–9 next. The society was founded in 1859 by Broca.

THE annual meeting of the German Bunsen Society of Applied Physical Chemistry is to be held at Aachen on May 23–26, immediately before the International Congress of Applied Chemistry in London. Among the subjects to be discussed is the application of physical chemistry to metallurgy.

THE Oliver-Sharpey lectures of the Royal College of Physicians will be given for this year by Prof. C. S. Sherrington, F.R.S., to-day, April 1, and to-morrow, at 5 p.m., at the Royal College. The subject of the lectures is "The *Rôle* of Reflex Inhibition in the Coordination of Muscular Action."

THE *Rendiconti del R. Istituto Lombardo* announces, under the prize awards of the society, a grant of 1000 lire to Dr. Umberto Savoia, for his studies in metallography, and a grant of 1500 lire to Prof. Ernesto Bertarelli, of Parma, for his work on syphilis. Among the subjects offered for the present and next year we notice Lie's theory of transformation groups, relations between the variations in wages and price of production, the colloidal state of matter, and the anatomy of the nervous system.

IN 1910 an exhibition, on an extensive scale, of the arts, sciences, manufactures, industries, and products of Great Britain and of Japan is to be held at Shepherd's Bush. The scheme is being supported by the Japanese Government, and the British Government is believed to be in sympathy with the project. Satisfactory arrangements have been concluded between the British organisers and representatives of the Japanese Department of Agriculture and Commerce.

IN NATURE of March 11 last (vol. lxxx., p. 47) attention was directed to the movement which is being organised by the British Empire League to provide London with a monument to Captain Cook. It was then pointed out that a general committee of distinguished persons had been formed, and that steps would be taken later to appoint an executive to collect the necessary funds, to determine the character of the memorial, and to select the best available site. A meeting of the general committee was held at the Mansion House on March 30 and elected an executive, on whom will devolve, in due course, the duty of issuing an appeal for funds and of taking the necessary steps for the erection of a memorial. The Prince of Wales has consented to become honorary chairman of the general committee, and Lord Brassey to undertake the duties of treasurer.

THE following are among the lecture arrangements at the Royal Institution after Easter:—Prof. F. W. Mott, two lectures on the brain in relation to right-handedness and speech; Prof. Svante Arrhenius, two lectures on cosmogonical questions (the Tyndall lectures); Prof. J. Garstang, two lectures on the Hittites, (1) monuments of Egypt and Asia Minor, (2) recent discoveries in Asia Minor and northern Syria; Dr. F. Gowland Hopkins, two lectures on biological chemistry; Mr. J. G. Millais, three lectures on Newfoundland; Prof. W. E. Dalby, two lectures on a modern railway problem, Steam *v.* Electricity; Mr. R. T. Günther, two lectures on the earth movements of the Italian coast and their effects; Dr. W. H. R. Rivers, two lectures on the secret societies of Banks' Islands; and Dr. F. F. Blackman, two lectures on the vitality of seeds and plants, (1) a vindication of the vitality of plants, (2) the life and death of seeds. The Friday evening meetings will be resumed on April 23, when Mr. Alexander Siemens will deliver a discourse on tantalum and its industrial applications. Succeeding discourses will probably be given by Major Ronald Ross, Prof. G. E. Hale, Dr. J. Emerson Reynolds, Prof. J. A. Fleming, and Sir James Dewar.

THE Royal Academy of Sciences and Letters of Denmark has issued a descriptive circular showing prize subjects proposed by it this year. In philosophy the subject is a critical consideration of Socrates and his philosophic influence since the time of Aristotle. The problem in astronomy is to examine the conditions in which it is possible to determine the mass of a comet, and to investigate whether these conditions are satisfied by comets which do not traverse exactly the orbits calculated for them by the usual methods. It is required that for at least one comet of this class the orbit should be calculated using the whole of the seven constants of the formulæ relating to the movement of two bodies, and that the results obtained should be compared with those of observation. The prize in physics is for a study of the influence produced by pressure, temperature, and wave-length upon the index of refraction of substances in the liquid and gaseous states. A prize is offered also for a study of the changes undergone by calcium cyanamide in the course of its manufacture for purposes of agriculture and during its use as a fertiliser. In each case the prize is the gold medal of the academy, having a value of about 18*l*. The papers may be written in Danish, Swedish, Norwegian, English, French, or Latin, and must be sent in before October 31, 1910, in each case except that of physics, the closing day of which is one year later. Further particulars may be obtained from the secretary of the academy, Prof. H. G. Zeuthen, The University, Copenhagen.

THE most important article in the January issue of the Annals of the Transvaal Museum is one by Dr. L. H. Gough on the South African lizards of the genus Agama, in which the various species are re-described and illustrated from spirit-specimens.

PREHISTORIC Scandinavian implements, with special reference to the use of deer-antlers, form the subject of an illustrated article, by Mr. J. A. Grieg, in the March number of *Naturen*. Another paper on the same subject, by Prof. A. W. Brøgger, but devoted chiefly to stone implements, although also containing illustrations of incised figures of certain animals, appears in the third part of the *Bergens Museum Aarbog* for 1908. Attention is likewise directed to some of the more remarkable types of these implements by Dr. H. Schetelig, the director of the historical and antiquarian section, in the *Aarsberetning* of the same institution for 1908. According to the last-named publication, the Bergen Museum continues to make satisfactory progress in all departments, special attention being directed to the mounting of groups of animals in imitation of their natural surroundings in the zoological section.

WE have to acknowledge the receipt of vol. x. of the third series of the *Annales del Museo Nacional de Buenos Aires*, a volume bearing the date 1909, although the whole of the numerous articles, with the exception of the two last, were separately issued during 1908. Of these, two by Dr. Ameghino, one dealing with the edentate shoulder-girdle and the other with the supposed fossil armadillos of France and Germany, have been already noticed in our columns. We may here refer to a paper by Mr. J. Brethes on the nests of the Argentine spider known as *Mastophora extraordinaria*. These minute spiders construct nests in the form of some half-dozen circular chambers of the size of large peas, each attached to the surface, from which they hang by a slender pedicel. They are made of a substance resembling *papier-maché*, and in colour are white with numerous irregular black blotches. In the interior of each is deposited a cluster of eggs. The receptacles have a perfectly uniform structure, and show no signs of a closed-up entrance hole. The marvel is how the spider contrives to introduce her eggs into these closed chambers.

THE report of a committee appointed by the Royal Society of Medicine to consider the request of the chief surgeon of the Metropolitan Police on the best method of artificial respiration in the case of the apparently drowned was adopted by the council of that society in July last, and a copy of the report has just reached us. The committee was fully representative, and included surgeons, physicians, and physiologists; Sir William Church acted as chairman. The report is unanimous, and recommends the simple and safe method introduced by Prof. Schäfer in preference to the older and more risky methods of Sylvester and Marshall Hall. We learn with satisfaction that the report has been officially accepted for adoption throughout the metropolitan area. We can only hope this example will be followed in other quarters. For the sake of our readers who may not be acquainted with the Schäfer method, and one never knows when the occasion may arise for its employment, we may add a brief description of the process. The individual is laid on the ground in the prone position with a thick folded garment under his chest. The operator kneels athwart him, facing his head, and places his hands on each side over the lower ribs. He then slowly throws the weight of his body forwards, and thus presses upon the thorax of the subject and forces air out of the lungs; he then gradually relaxes the pressure by bringing his body up again, but without removing his hands. This is repeated regularly at the rate of twelve to fifteen times a minute until normal respiration begins or until all hope of restoration is given up; but it is best to persevere for at least an hour.

AN insect has appeared in Antigua that causes the dropping of the flower buds of cotton, and an investigation on the spot has been made by Mr. Ballou, whose preliminary report is published in a recent issue of the *Agricultural News*. The insect was found living on the wild cotton, and apparently on privet, and is now being further examined.

WE have received the current number of *Tropical Life*, a monthly journal devoted to those interested in tropical or subtropical countries. It contains several useful articles on important tropical crops, such as cacao, pea-nut, and sisal, as well as notes on appliances likely to prove useful on tropical estates. Market reports are also given, and general articles calculated to interest those whom the journal is designed to serve.

NOW that the interest in breeding problems has become so widespread, it is very necessary to have some system of records by which the parentage of any particular individual breed during the experiment may be at once ascertained. The method adopted at the Rhode Island Agricultural Experiment Station for keeping pedigree records is described by Dr. L. J. Cole in the annual report of the station. It is a modification of Galton's method (NATURE, 1903, vol. lxix., p. 586), and is worked on the card-index system, giving each individual a separate card; the advantage claimed for it is that it enables the ancestors and the descendants of any individual to be traced with very little difficulty.

THREE bulletins from the United States Department of Agriculture Bureau of Entomology are to hand. Dr. Ball discusses (No. 66) the leaf-hoppers of the sugar-beet and their relation to the "curly leaf" condition. *Eutettix tenella* is described at length; illustrations and descriptions are also given of other species of Eutettix, of Agallia, and of a small green Empoasca. It is concluded that *Eutettix tenella* is responsible for one common kind of "curly leaf." In No. 104 Dr. Chittenden deals with the red spider (*Tetranychus bimaculatus*), which is particularly injurious to violets, roses, melons, cucumbers, tomatoes, &c. This spider resists fumigation with tobacco or hydrocyanic acid more than many other insects, but it is destroyed by sulphur or soap solution. In Bulletin No. 344 Mr. W. D. Hunter deals, from the farmer's standpoint, with the cotton-boll weevil, which does a great amount of damage each year; the loss caused by the weevil since it invaded the States is estimated at 125,000,000 dollars.

THE influence of breed on egg-production in poultry is well seen in a report recently issued by Messrs. E. and W. Brown from University College, Reading. Danish, American, and English Leghorns were kept under comparable conditions for twelve months, and careful record was kept of the number of eggs laid. The Danish birds had been bred to yield a large number of eggs of moderate size; the English birds, on the other hand, had been largely bred for exhibition purposes, for which egg-producing capacity is not needed. The consequence is seen in the following table:—

	Danish brown Leghorns	American white Leghorns	English white Leghorns
Average number of eggs per bird...	153·7	142	76
Average weight of each egg...	2·12 oz.	2·34 oz.	2·05 oz.
Percentage of eggs weighing less than 2 oz. ...	1·8	0·5	32·9

The profit on the English birds is shown to be much less than that on the Danish or American birds.

THE tenth report of the Woburn Experimental Fruit Farm follows closely on the ninth, and deals with the treatment of trees for insect pests. It was found that nursery stock could be freed entirely from woolly aphis by immersion for ten minutes in water heated to 115° F., at which temperature the plants did not suffer. Treatment with petrol was equally effective so far as the destruction of aphis was concerned, but might be likely to cause more damage to the plants. On the other hand, fumigation with hydrocyanic acid was both risky and uncertain, and is not recommended by the authors. Trees infested with aphis could be cleansed by spraying with light paraffins like petrol in the undiluted state, but their leaves suffer so much that the method should only be adopted in extreme cases. It is shown that injection of paraffin into the soil produces but little direct injury to the tree, and there seems the possibility that it might prove a useful method for killing the insects that harbour round the roots, and that do a good deal of harm by their migrations to the branches. Experiments were also made with nicotine, which was found to destroy Psylla, but not caterpillars. Paraffin emulsion, however, proved quite fatal to the caterpillars of the winter moth, the gooseberry saw-fly, and the currant saw-fly, and had the further advantage of not interfering with the sale of any fruit which might happen to be on the bushes at the time.

A SHORT practical pamphlet on lawns, prepared by Mr. W. J. Stevens, has been published in the series of "One and All" garden books. It contains the necessary information on the making of lawns with turf or with seed, renovation and manuring, also a list of suitable varieties of grass seed. It concludes with a few hints by Tom Hearne on cricket and tennis grounds.

IT is now generally recognised that bakers prefer strong wheats, because the flour gives a more shapely loaf. Soft wheats have been recommended for Indian cultivation in

the past, but a trial of samples, recorded by Mr. A. Howard in Bulletin No. 41 of the Agricultural Research Institute, Pusa, reverses the verdict. Of ten samples, three hard wheats from the Punjab furnished good results, but they were excelled by a new hard wheat selected for cultivation at Pusa. All four varieties yield good straw, and are considerably rust resistant. It is noteworthy that the order of all ten samples, based on baking tests, corresponded exactly with their nitrogen content.

THE economic value of certain Australian pasture grasses forms the subject of an article by Mr. F. Turner, published in the *Kew Bulletin* (No. 1). *Trigonella suavissima*, a clover-like plant, makes good forage, or may be served as a vegetable; similarly, *Tetragonia expansa*, receiving the name of Warrigal cabbage, may be used in both ways. *Boerhaavia diffusa*, known as hog weed, and *Geranium dissectum* are forage plants bearing fleshy roots that formerly provided food for the aborigines. *Erodium cygnorum* is another herb that in the young succulent stage is much relished by stock. *Calandrinia balonensis* contains moisture as well as nutrition in its succulent leaves, and *Portulaca oleracea* is similar. A plantain, *Plantago varia*, affords good pasture, and *Psoralea tenax* receives the name of native lucerne, while the plant known as nardoo is the hydrophytic fern *Marsilea quadrifolia*.

THE section Gamopetalæ is completed in the twenty-first part of "Materials for a Flora of the Malayan Peninsula," that is reprinted from the Journal of the Asiatic Society of Bengal (vol. lxxiv., extra number, 1908). This part contains the family Gesneraceæ, for which Mr. H. N. Ridley is responsible, and the family Verbenaceæ, collated by Mr. J. S. Gamble. A large number of new species were described by Mr. Ridley in 1905, to which are now added two new species of Æschynanthus, and *Lepadanthus flexurus*, the type of a new genus. Didymocarpus is the most important genus as regards the number of species. Several of the genera are confined to the Malayan or Indo-Malayan regions. The diagnoses of several new species in the Verbenaceæ were published in the *Kew Bulletin* for 1908. Premna, Vitex, and Clerodendron are large genera; *Vitex peralata* is noted as an ornamental tree worthy of cultivation.

IT may be hoped that the appointment of Mr. N. W. Thomas on the anthropological survey of the Niger delta will not lead to the discontinuance of his "Bibliography of Anthropology and Folk-lore," of which the second annual issue for 1907 has recently appeared, at the modest price of two shillings, under the auspices of the Royal Anthropological Institute and the Folk-lore Society. It deals only with books and periodicals published within the British Empire, with a few references to English publications on countries like China; there is no attempt to include more than prehistoric archæology, and only unwritten languages are noticed. The range of the compilation is thus limited, but it is useful so far as it goes, and its publication emphasises the urgent need of concerted action. The work is of a kind which should not depend upon the labours of any single worker, however energetic. Surely the societies which deal with the phases of man's life, past and present, might combine to do what the Royal Geographical Society so admirably accomplishes in the bibliography contained in its monthly journal.

MR. A. LANG, in a paper published in vol. iii. of the Proceedings of the British Academy, discusses the origin of the terms of human relationship. He suggests that "own" relations, maternal or paternal at least, were recognised before the evolution of the family groups into the tribe introduced "tribal" mothers, brothers, and sisters. Then, as tribal law developed, regulating all things by grade of age, the old names for the nearest relationships were simply extended (sometimes with qualifications, such as "elder," "younger," "little") to all persons of the same age-grade, in the same phratry, with the same duties, privileges, and restrictions. He sums up the discussion in the provisional conclusion that the classificatory, widely inclusive terms of relationship prove nothing, neither for nor against a theory of primal promiscuity. The material for these inductions is largely drawn from the Arunta and other Australian tribes, about whom our information is still very incomplete. It is difficult, for instance, to reconcile the accounts of the Arunta given by Messrs. Spencer and Gillen with those of later observers, and Mr. Lang, in his analysis of Australian terms of relationship, depends largely on analogies drawn from Aryan languages. The value of such material interpreted by such methods is obviously small, and our anthropologists would be well advised to defer speculation on the sociology of primitive man in general until the customs and languages of the native Australians, which supply evidence essential to such an inquiry, have been ascertained with much greater certainty.

THE stone implements of the French older Palæolithic age have been recently critically studied by Dr. Hugo Obermaier, with special reference to their stratigraphy and evolution (*Mitteilungen der prähistorischen Kommission der Kais. Acad. der Wiss. Wien*, Band ii., No. 1, 1908, pp. 41–125, 134 figures in text). The relative chronology of forms of implements suggested by G. de Mortillet is confirmed and amplified. Dr. Obermaier's results may be very briefly summarised as follows. An Early Chellian period, devoid of hand-wedge (Faustkeil) implements, was followed by the High Chellian, characterised by its primitive hand-wedge (Urfaustkeil) implement. The Acheulean evolving therefrom must be divided into an older and newer period, as exemplified in the forms of the hand-wedge. The groups of "La Micoque" and "Levallois" are subdivisions of the latter. The hand-wedge is either absent or completely decadent in the Mousterian age. In *Le Préhistorique* (1900) G. and A. de Mortillet state repeatedly that the hand-wedge (*coup de poing*) was the sole implement of the Chellian age, and that the chips of this age are of no significance; but in this they are mistaken, since numerous smaller implements have been recognised; for example, the scraper and blade appear in the Early Chellian, borers and punchers also occur in Chellian deposits, as do a cutting implement with a dressed arched back, and some other tools. The numerous illustrations render this paper indispensable to those who desire to trace the evolution of the various types of flint implements during the earlier phases of the Palæolithic age.

FROM the offices of the Egyptian Survey Department, Ministry of Finance, we have received a copy of a very useful almanac for 1909, which contains much information concerning the various Government and public offices and institutions of Egypt. Under the title of "General Information" we find numerous tables concerning meteorological data, the height of the Nile, the planting and reaping of various crops, and the conversion of weights, measures, and money. The almanac has been compiled by the Survey Department, and is sold for 25 *milliemes* (6½*d.*).

MM. FLAMMARION and Loisel give their usual summary of the climatology of the past year (1908) in the February

and March numbers of the *Bulletin de la Société astronomique de France*. The results are founded on the observations made at the Juvisy Observatory, and deal with temperature, pressure, rainfall, insolation, cloudiness, &c. Numerous curves show the daily or monthly march of each element, whilst other curves and tables compare the results with those of previous years since 1886. Comparisons are also made of the seasons, and those having similar meteorological records in different years are grouped together in a very handy form for reference. In a general remark, the observers state that for several years now late summers have been the rule.

THE director of the meteorological observatory, Chemulpo, has sent us the results of the observations made at six Japanese meteorological stations in Korea for each of the months January–December, 1907. The observations are made thrice daily, with monthly summaries, and are a valuable contribution to the meteorology of the Far East. An annual summary would be a very useful addition to the tables, which have been very carefully prepared by Mr. Y. Wada. The instruments and method of observation are the same as those at the meteorological stations in Japan; this is a sufficient guarantee of their accuracy.

THE fifteenth annual report of meteorology in Mysore, for 1907, has been received, containing daily and monthly means for the second-class stations of Bangalore and Mysore, and 8h. a.m. observations and means for the third-class stations of Hassan and Chitaldrug. The altitude of these important stations varies from approximately 2400 feet at Chitaldrug to 3100 feet at Hassan, and they lie at the corners of a quadrilateral of which the diagonal, ninety-seven miles in length, is almost due west, Bangalore, the easternmost station, being 190 miles west of Madras. The observations have been very carefully discussed by Mr. N. V. Iyengar, chief observer in charge, and include mean values for the years 1893–1907. The absolute maxima of shade temperature during that period exceeded 100° at all stations, and reached 103° at Chitaldrug; the lowest reading was 42°·7, at Hassan. On extreme occasions relative humidity fell to between 4 per cent. and 6 per cent. at the different stations. The mean yearly rainfall varied from 25·6 inches at Chitaldrug to 35 inches at Bangalore.

A CORRESPONDENT, Mr. A. E. H. Bott, of Fishburn, Alberta, asks for information on a matter which is of common interest to many where severe cold is experienced. An ordinary horizontal minimum thermometer filled with coloured alcohol was placed about 6 feet above the ground on the north wall of a house. The instrument registered from −60° F. to +114°. In the early part of January the thermometer registered from −35° to −53° for about six or seven nights in succession. The thermometer was tilted every day in order to replace the index at the end of the thread of alcohol. The thermometer was afterwards left untouched for some days, while the observer was away from home, and it was then found that the colouring matter, apparently the red of cochineal, had entirely left the upper part of the thread, which was now difficult to see. When writing, the top of the column stood at +14°, but the deep-red colour began to pale at about −50°, and faded gradually until it disappeared completely at about −14°. It seems probable that the cochineal was frozen out of the solution, and that the mixture was rather mechanical than chemical. In all probability heating or warming the mixture would restore the instrument to the same condition as when purchased, but a recurrence of the separation of the colouring matter with extreme cold seems probable.

IN the Bulletin of the American Mathematical Society for March, Miss Eva M. Smith discusses some surfaces having a family of helices as one set of lines of curvature. From the investigation it appears that surfaces can exist one set of the lines of curvature of which are general helices defined by constant ratio of curvature and torsion, but no surfaces have regular helices (*i.e.* helices on right circular cylinders) for their lines of curvature.

THE February issue of the Journal of the Institution of Electrical Engineers contains Mr. W. R. Cooper's paper on the tariffs now in force for the supply of electricity for domestic purposes. He considers that their present tendency is to discourage the demand for electricity, and advocates with much force the substitution for them of the payment of a fixed sum per annum based on the number and power of the lamps installed, *plus* a small charge, not exceeding one penny per unit, for the electricity used. In the discussions of Mr. Cooper's paper, which took place in London, Glasgow, and Dublin, widely divergent opinions were expressed by lighting engineers as to the relative merits of the old and the proposed systems, but almost all were agreed that some reform is necessary if the more extensive use of electricity for domestic purposes is to be encouraged.

METALLURGISTS who have not made a special study of the accurate measurement of high temperatures, and who are therefore not in a position to judge of the relative merits of the various determinations of the melting point of iron, will be very grateful to Prof. Carpenter, of Manchester, for a critical summary of our knowledge on the subject, which appears in part iii. of the Journal of the Iron and Steel Institute for 1908. After a brief statement of the relations of the gas, the thermo-electric and the optical temperature scales to each other, Prof. Carpenter gives the results obtained during the last five years by observers at the national physical laboratories of Germany, France, America, and England, and concludes that the freezing point of iron is 1505° C. on the thermo-electric temperature scale, which corresponds to 1519° C. on the optical scale as at present used.

WE have received eight pamphlets forming appendices to the annual reports of the Coast and Geodetic Survey from 1899 to 1906, which deal with the observational magnetic work carried out in the United States under the supervision of Dr. L. A. Bauer, chief of the division of terrestrial magnetism. These appendices consist largely of observational data, accompanied by descriptions of the stations where the observations were made. Particular care is taken in indicating the exact sites, which are marked with wooden pegs or stone blocks. In addition to observational details there are descriptions of the magnetic observatories of the Survey and their instrumental outfit, as well as of the field instruments. The instruments at the fixed observatories seem mainly of German origin. Of the field instruments, the magnetometers are of a special pattern—a combined magnetometer and theodolite—made in the Survey's workshops. The dip circles—including the ordinary land pattern and the Lloyd-Creak for use at sea—are mostly of English make. Fitted with Lloyd's total-force needles and an auxiliary compass, the dip-circle seems to have proved a very useful universal instrument. The latest of the publications contains an isogonic chart for the United States for the epoch 1905, based on results from some 3500 stations, and it also gives tables of secular change—a good many extending back to 1750—for some eighty stations. Lists of observers in several years include more than thirty names, and it is abundantly clear that

magnetic work has an importance attached to it in the United States to which there is hardly a parallel elsewhere.

A PAPER on the construction and wear of roads, by Mr. H. A. R. Mallock, F.R.S., was read before the Institution of Civil Engineers on March 23. The subject was considered from a theoretical point of view with regard to the foundation of the road, its surface, and the character of the traffic. It was suggested that roads with a hollow cross-section, drained by a central gutter covered by a continuous grating, would be worthy of trial, as tending to prevent the accumulation of mud and water close to the footways, and as giving the greatest facilities for keeping the whole of the roadway clean. The origin of dust and mud on roads is imputed almost entirely to the grinding and crushing action of iron tyres and iron horseshoes. The conclusion drawn from the whole of the evidence is that the chief enemies of good roads are iron tyres and iron-shod horses, or, indeed, any forms of traction which cause very intense local pressure on the road surface. The view was expressed that with soft tyres the wear on any good road is extremely small, and with pneumatic tyres still less, but that so long as iron tyres and iron-shod horses are used for traction, the best means of preserving a clean and unbroken road surface is to be found either in the applications of tar (many of which have already been made with considerable success), or in some other method which will give the same large limits of elasticity and rupture to the upper layer of road material. For roads used exclusively by soft tyres there is a far wider choice of suitable road material than where the surface is exposed to very intense pressure.

A SECOND edition of Dr. M. Abraham's "Elektromagnetische Theorie der Strahlung" has been published by the firm of B. G. Teubner, of Leipzig and Berlin. This work is the second volume of the "Theorie der Elektrizität," reviewed in our issue for August 15, 1907 (vol. lxxvi., p. 377). The price of the present part is 10 marks.

WE note with interest and satisfaction the publication of German editions of two well-known works of science originally published in English. The first is "Habit and Instinct," by Prof. Lloyd Morgan, F.R.S., which has been translated by Maria Semon, and issued by the firm of B. G. Teubner, of Leipzig and Berlin, at the price of 5 marks. The second is Prof. Alexander Smith's "Introduction to General Inorganic Chemistry," translated by Dr. Ernst Stern, and published by the firm of G. Braun, of Karlsruhe.

OUR ASTRONOMICAL COLUMN.

ASTRONOMICAL OCCURRENCES IN APRIL:—

April 1. 22h. Jupiter in conjunction with the Moon (Jupiter 3° 45′ S.).
2. 22h. Saturn in conjunction with the Sun.
3. 9h. 55m. to 11h. 5m. Moon occults ν Virginis (mag. 4·2).
10. 9h. 8m. to 12h. 34m. Transit of Jupiter's Satellite III. (Ganymede).
,, 15h. 52m. to 16h. 32m. Moon occults b Ophiuchi (mag. 4·3).
13. 19h. Mars in conjunction with the Moon (Mars 2° 29′ N.).
15. 10h. 30m. to 14h. 46m. Transit of Jupiter's Satellite IV. (Callisto).
19. 9h. 43m. Minimum of Algol (β Persei).
19–22. Epoch of Lyrid meteors. (Radiant 271°+33°.)
21. Venus. Apparent diameter 9″·8.

THE ROTATION OF THE SUN.—In a paper appearing in the March number of the *Astrophysical Journal* (vol. xxix., No. 2, p. 110) Prof. W. S. Adams gives and discusses the results obtained during 1908 in the spectroscopical investigation of the sun's rotational velocities. In general, these results agree closely with those obtained during the 1906–7 investigation, although for latitudes greater than 50° larger values are now obtained for the velocity; there is no evidence, however, of the existence of a variation of the rate of rotation. Lines of lanthanum and of cyanogen are again found to give low values, as are also two "enhanced" lines investigated. On the other hand, certain lines of manganese and iron indicate high velocities. In general, such abnormal behaviour becomes more marked in the higher latitudes.

The present results were derived from spectrograms taken with the tower telescope and the 30-feet spectroscope, and show a marked increase of probable accuracy over those obtained with the smaller equipment in 1906–7. They also show that Faye's equation for the rotation holds quite good up to within 10° of the poles. Special plates taken with solar vortices in the field show that the vortices may introduce variations of such magnitude as to invalidate any conclusion normally derived from the measures.

Special studies were also made of the behaviour of the calcium line at λ 4227 and of the Hα line, and it was found that both give high rotational velocities; such abnormalities are explained by the greater height reached by the matter producing these lines. The former line was found to be indubitably double, although the separation of the components is extremely small. The study of Hα gave some very interesting results, among which we may mention that at different distances from the limb this line indicates very different velocities; it also shows only a slight equatorial acceleration.

COMMON MOTIONS OF THE PRINCIPAL URSÆ MAJORIS STARS.—A number of investigators have discovered evidence of a probable physical connection between the seven principal stars of the constellation Ursa Major, and in Nos. 4313–4 of the *Astronomische Nachrichten* Dr. Ludendorff again discusses the question on the basis of radial velocities determined at Potsdam.

The radial velocities of β, ϵ, and ζ Ursæ Majoris were investigated. In the case of β, the measures indicate a variable velocity with a period of about 27·16 days. The absolute values found for ϵ can only be looked upon as approximate, but they indicate a variability of restricted range and long period, the variation being between −8 km. and −18 km., with a period of about 2·1 years. The centre of gravity of the system of ζ Ursæ Majoris is shown to have a large range (269 km.) of velocity, with a period of 20·536 days.

Considering together the proper motions and parallaxes of the seven stars, it is found that there are probably two connected systems, system i. including β, γ δ, ϵ, and ζ, and system ii. including α and η, both of which have approximately the same parallax and the same velocity relative to the sun, but the angle between the directions of the two systems is about 101°.

THE SURFACE OF ROTATING MERCURY AS A REFLECTING TELESCOPE.—Having made a striking series of experiments on the possibilities of the paraboloidal surface of rotating mercury as a reflecting telescope, Prof. R. W. Wood describes and illustrates his results in No. 2, vol. xxix., of the *Astrophysical Journal* (p. 164, March).

Prof. Wood succeeded, by very finely adjusting the motion of his rotating tank, in producing mercury surfaces on which the disturbances were negligible, and for which a constancy of focus could be maintained for some time. Although the experiments appear, at first glance, to be merely of theoretical interest, Prof. Wood is so gratified with the results that he suggests methods whereby results of practical interest might be obtained. One of these is the possibility of taking casts, in some easily fusible material, of sufficient rigidity when solidified to bear electrotypes being made from it. These electrotypes, suitably mounted and silvered, might then be used in reflecting telescopes.

PHOTOGRAPHS OF THE EARTHSHINE ON THE MOON.—Two excellent photographs, showing the greater part of the

lunar surface illuminated by the light reflected from the earth, are reproduced in the March number of the *Bulletin de la Société astronomique de France*.

Whilst most people are familiar with the appearance of the moon thus partially illuminated, it is not an easy matter to photograph the phenomenon successfully, but on these photographs many lunar details are shown quite well, except in the sunlit crescent, which is, of course, much over-exposed.

The photographs were taken by M. Quénisset at the Juvisy Observatory, using the Viennet objective of 16 cm. aperture and 2·90 m. focal length, with ten minutes' exposure on a fast plate at the focus.

COSMICAL MATTER IN SPACE.—In his address as retiring president of the Royal Astronomical Society, Prof. Newall directed attention to, and briefly discussed, the possibility that the chief characteristic spectroscopic phenomena of the sun and the stars are mainly produced by matter streaming into these bodies from without rather than by matter brought from their interior layers to their radiating surfaces.

Appealing to various solar, cometary, and physical phenomena, Mr. Newall educed evidence that this view of astrophysics is not an obviously impossible one, and would, if found acceptable, account for several outstanding anomalies (Monthly Notices, R.A.S., vol. lxix., No. 4, February).

OBSERVATIONS OF VARIABLE STARS.—During 1908 Prof. Nijland observed, at the Utrecht Observatory, twenty-one Algol variables, six short-period variables, three variables of the U Geminorum type, SS Cygni, and forty-five long-period variable stars. The results of these observations now appear in No. 4309 of the *Astronomische Nachrichten*, together with a series of notes dealing with any special features observed.

THE CARNEGIE INSTITUTION OF WASHINGTON.

THE seventh year-book of the Carnegie Institution of Washington, for 1908, has just been received, and consists of reports of the president and the executive committee, and of directors of departments and other grantees who, with the assistance of the institution, have been carrying on investigations during the year.

The president's report gives the following facts and figures indicating the growth and extent of the work so far undertaken and accomplished by the institution. Since its organisation, in 1902, about 1000 individuals have been engaged in investigations under the auspices of the institution, and there are at present nearly 500 so engaged. Ten independent departments, each with its staff of investigafors and assistants, have been established. In addition to these larger departments of work, organised by the institution itself, numerous special researches carried on by individuals have been subsidised. Six laboratories, for as many different fields of investigation and in widely separated localities, have been constructed and equipped. Work in almost every field of research, from archæology and astronomy to thermodynamics and zoology, has been undertaken, and the geographical range of this work has extended to more than thirty different countries.

At the end of the fiscal year, October 31, 1908, 120 volumes of researches in nineteen different fields of research, with a total of more than 30,000 pages, had been published, and twenty-seven volumes of researches were in the press. In addition to these publications issued by the institution, about 1000 shorter papers have been published in the current journals of the world by departmental investigators, by associates, and by assistants. The total amount of funds allocated for expenditure to November 1, 1908, was 737,000*l*., which included 59,000*l*. reverted and afterwards re-appropriated. The total amount expended was 672,000*l*.

During the past year the Nutrition Laboratory in Boston has been equipped, and systematic investigations are already in progress.

The construction of a building in Washington, D.C., at the south-east corner of Sixteenth and P Streets, N.W., was begun a year ago. This building is for administrative offices and the storage of records and publications, and when completed will cost about 44,000*l*.

The plans and specifications for the construction of a specially designed ship for ocean magnetic work have recently been completed. These plans require a non-magnetic sailing vessel with auxiliary propulsion. She will be classified as a yacht, will be called the *Carnegie*, and will, upon completion, proceed upon a magnetic survey of the Atlantic Ocean under the direction of the department of terrestrial magnetism of the institution. The grant for the construction of this vessel is 8000*l*.

A temporary observatory for supplementary measures of the positions of the fixed stars of the southern hemisphere is now being built at San Luis, Argentina, under the direction of Prof. Lewis Boss, head of the department of meridian astronomy of the institution. Prof. R. H. Tucker will be resident astronomer in charge of the work of observing and computing in South America, which will require three to five years for completion. The meridian instrument of the Dudley Observatory, the constants of which have been thoroughly investigated, will be transferred to San Luis and used in securing the desired measurements of the positions of stars in both hemispheres.

Work in the other departments of the institution has progressed rapidly and successfully. The investigations of Dr. G. E. Hale, director of the Solar Observatory on Mount Wilson, California, are of great interest. During the year, with the aid of his exceptional equipment, the discoveries which have been made with regard to sun-spots will probably prove of as great importance to terrestrial and molecular physics as to solar physics. The progress inaugurated may be confidently expected to lead rapidly to definite and important results. The expenditure on account of the site, buildings, instruments, and other appliances of the observatory was, up to September 30, 1908, 71,631*l*.

Under the direction of the department of historical research, work upon manuscript materials for American history has been pursued in France, Italy, and England, and next year will be extended to Germany. Many remarkable experiments and investigations are in progress under the department of botanical research at the Desert Laboratory at Tucson, Arizona.

In addition to the work carried on in the departments of the institution during the year, thirty-one grants were made to individuals and organisations in aid of researches conducted by them, and many other researches begun in former years have been carried forward. The publication of twenty volumes was authorised, and twenty-seven volumes and an atlas have been published. The latter include the report upon the California earthquake of April 18, 1906, a handbook of learned societies and institutions of North and South America, and a reproduction of the "Old Yellow Book," the source of Browning's "The Ring and the Book." These volumes and others issued by the institution are offered for sale at the cost of printing and transportation to purchasers.

At the annual meeting of the board of trustees on December 8, 1908, the sum of 127,260*l*. was allocated to carry on work of investigation, publication, and administration during the year 1909.

RECENT PAPERS ON DARWINISM.

THE *Fortnightly Review* for March contains an admirable article, by Dr. A. Russel Wallace, on "The World of Life, as Visualised and Interpreted by Darwinism." The veteran author argues with all his old vigour and eloquence in favour of the theory of the origin of species by natural selection, bringing out the facts of extensive and independent variation under natural conditions, emphasising the reality of the struggle for life, and insisting on the facts of adaptation as inexplicable under any other hypothesis than that of Darwin. He

shows how the commonest of the popular objections to the theory "rests upon the strange belief that variation is a rare phenomenon, that favourable variations occur singly and at long intervals, and, therefore, can have no effect in producing any important change"—an idea which is entirely at variance with the actual facts of nature. But while strenuously upholding the sufficiency of the Darwinian explanation of the phenomena of life within its own sphere, he still allows that "neither Darwinism nor any other theory in science or philosophy can give more than a secondary explanation of phenomena."

A paper by Mr. E. S. Russell in the Bologna *Rivista di Scienza*, entitled "The Evidence for Natural Selection," affords a good illustration of the tone, alternately patronising and depreciatory, which certain writers think fit to adopt in speaking of the epoch-making work of Darwin. After noticing several of the well-known cases in which the operation of natural selection has been actually demonstrated, and after so far giving his approval as to say that "the theory of natural selection . . . is a very suggestive and valuable one," the author thinks it sufficient to add that "it is highly probable that natural selection has played a part in evolution," and that it is "the formula of what seems to be a general process in nature, but it is a formula without much content." This is indeed to damn with faint praise. The paper concludes with the cryptic utterance that the theory "must become largely superseded by the very deepening of our knowledge of it."

Another paper in the *Rivista* by the same writer, on the "Transmission of Acquired Characters," contrives to introduce confusion into what is essentially a very simple issue. It is of great importance to know whether a modification induced upon the soma can be transmitted by inheritance; it is of comparatively little importance to know whether soma and germ can be affected in common by the same external agent, as, for example, by temperature in the case of cold-blooded animals like insects. The two ideas are essentially distinct, and nothing is to be gained by attempting to identify them.

Darwinism and Darwin loom large in other recent publications. The *American Naturalist*, for instance, contains five articles on these subjects, communicated, in the first instance, to a special Darwin memorial session held at Baltimore by the Botanical Society of America. In these Prof. W. Trelease discusses Darwin as a naturalist, and his work on cross-pollination in plants; Prof. F. E. Clements follows with an inquiry into the influence of Darwin in relation to the geography and ecology of plants; while Prof. H. M. Richards winds up with a review of Darwin's on plant-movements. In an independent article, which did not form part of the Baltimore meeting, Prof. E. Linton examines and criticises the "Origin of Species" in the light of recent observations and experiments.

To the March issue of *Himmel und Erde* Prof. Plate communicates a centenary eulogy on Darwin, originally delivered as a lecture at a festival meeting on Darwinism and evolution, held at the Royal Agricultary High School, Berlin. The *Zoologist* for March also has an article, by Prof. W. C. McIntosh, of St. Andrews, on the Darwinian theory in 1867 and now. This is a reprint, with interpolations, of a lecture given by the author in March of the year referred to before the Literary and Antiquarian Society of Perth. One passage in the original lecture, relating to "the appearance of the various species of Ichthyosaurus in the marine strata of the Chalk period, and the utter blank in reference to any form calculated to throw light on their origin," was incorrect when originally written, and now stands in urgent need of an explanatory paragraph in view of modern discoveries.

To the March number of *Rassegna Contemporanea* (published in Rome) Mr. Ugo Giovannozzi contributes an article on Darwin's life and works. The article is divided into sections, each dealing with separate periods of the career of the great evolutionist, special attention being directed to the influence of the voyage in the *Beagle* on his opinions, and to the appearance of the "Origin of Species." In the concluding paragraphs reference is made to Darwin's views on religion.

"Der gegenwartige Stand der Abstammungslehre" is the title of a pamphlet, by Prof. L. Plate, published in Berlin, which purports to be a popular explanation of the doctrine of evolution. After stating that evolution is supported by an overwhelming amount of evidence, and that no other theory is in existence capable of taking its place, and with a reference to its importance to mankind in general and to its bearing on religious belief, the author proceeds to state that, in his opinion, Darwin's selection-theory affords at present the only satisfactory explanation of the mode in which evolution has acted. The mutation-theory of de Vries, he adds, is not new in principle, but merely a restricted form of the selection-theory. Mutations are nothing more than pronounced variations, which Darwin called fluctuations or individualities.

THE ELECTRICAL PROPERTIES OF FLAME.[1]

WHEN a flame is brought near to an insulated conductor charged with electricity, the charge disappears. This is explained by supposing that the gases in the flame are partially dissociated into ions. A neutral molecule splits up into two ions, one having a negative charge and the other a positive charge. The conductor, if positively charged, attracts the negative ions out of the flame, and their charges when they reach it neutralise its charge.

When a plate of an insulator, such as ebonite, is placed between the flame and the charged conductor, the ions are still attracted through the plate, but when they reach it they cannot get through, and so remain on its surface. The side of the plate turned towards the flame thus gets a charge of opposite sign to that on the conductor. This shows that the disappearance of the charge in the first case was due to an opposite charge attracted out of the flame, and not to the charge on the conductor escaping into the flame.

We have a stream of gas rising from the flame, and the ions go up in the stream. The ions of opposite sign attract one another, and when two come together their charges are neutralised, and the two ions are said to have disappeared by re-combination. Thus as we go up in the stream of gas from the flame the number of ions diminishes. If the stream of gas is allowed to pass up a long tube containing along its axis a series of charged electrodes, then the bottom electrode will be discharged first, and then the next one, and so on. The ions are used up in discharging the electrodes, so that the electrodes are discharged in order, beginning with the lowest one. When the lower electrodes have been discharged, the upper ones begin to be discharged, but more slowly, because many of the ions disappear by re-combination before they get far up the tube. Another effect also comes in; as the gases cool down the ions do not move so freely through them, and are not so easily attracted by the electrodes. This makes the rate of discharge of the upper electrodes still slower.

Thus, as we go down towards the flame the number of ions and their mobility rapidly increases, and right inside the flame the number is so large that the flame behaves like a good conductor of electricity.

When the terminals of an induction coil are connected to two Bunsen burners, sparks can be passed from the tip of one flame to the tip of the other. The temperature of the flame is about 2000° C., so that the density of the gases in it is about one-seventh of their density at the ordinary temperature. The potential difference required to send a spark through the flame is about the same as that required to send a spark through an equal length of air at one-seventh of ordinary atmospheric pressure. It appears, therefore, that the ions do not make it easier for a spark to pass. This is due to the fact that the current in the spark is greater than the ions can carry, so that the potential difference has to be enough to produce more ions, and so is the same in the flame as in un-ionised air at the same density.

[1] Discourse delivered at the Royal Institution on Friday, February by Prof. H. A. Wilson, F.R.S.

To study the conductivity of flame, it is convenient to use a row of small Bunsen flames placed so that they touch each other. I use a row of fifty flames burning from quartz tubes 1 cm. apart. This gives a flame 50 cm. long and about 10 cm. high. The quartz tubes insulate very well, so that a current can be passed along the flame horizontally from one end to the other.

When two parallel platinum electrodes immersed in the flame are connected to a galvanometer and battery, it is found that a measurable current is obtained. The relation between the current (i) and the difference of potential (V) between the electrodes is given by the equation

$$V = Ai^2 + Bdi,$$

where A and B are constants, and d denotes the distance between the electrodes. If d is small, say one or two millimetres, the term Bdi is negligible (except when i is very small), and we get $V = Ai^2$. In this case the current is almost independent of the distance between the electrodes.

The reason for this peculiar relation between the current and potential difference becomes apparent when the variation of the potential along the flame from one electrode to the other is examined. An electrometer is connected to two platinum wires, which are immersed in the flame, and can be moved along horizontally between the electrodes. Each wire takes up the potential of the flame at the point where the wire is situated, so the deflection of the electrometer indicates the difference of potential between the two points where the wires are put in. Suppose one wire is allowed to touch the positive electrode and the other is gradually moved along the flame from the positive to the negative electrode. It is found that in the space between the electrodes there is a small uniform potential gradient, but near each electrode there is a comparatively sudden drop in the potential. The drop near the negative electrode is much larger than the drop near the positive electrode. Thus nearly all the electromotive force of the battery is used up close to the negative electrode. This shows that nearly all the resistance offered by the flame to the passage of the current is close to the negative electrode. The positive ions in the flame move towards the negative electrode and the negative ions towards the positive electrode; in fact, the current is carried through the flame by these two streams of ions. Hence, close to the negative electrode, the current must be carried entirely by positive ions moving towards it, and at the positive electrode the current must be entirely carried by negative ions. We find that the resistance near the negative electrode is much greater than near the positive electrode, so that we conclude that the negative ions carry the current more easily than the positive ions. With a given electric force, the negative ions move very much faster than the positive ions. It has been shown experimentally that the velocity of the negative ions is about 10,000 cm. per sec. for one volt per cm., while that of the positive ions is about 100 times smaller than this.

In the flame away from the electrodes the electric force is found to be proportional to the current, so that here the flame obeys Ohm's law like a metallic conductor. Its conductivity is about 10^{11} times less than that of copper. In the equation $V = Ai^2 + Bdi$, the term Bdi is the part of the E.M.F. used up between the electrodes, so it is proportional to the current and to the distance. Sir J. J. Thomson has shown theoretically that the drop of potential near the electrodes should be proportional to the square of the current, as is found experimentally to be the case.

The conductivity of a Bunsen flame may be compared with the conductivity of liquids, such as water. In pure water some of the molecules are dissociated into ions and the water is a conductor, although only a poor one; but if a salt like sodium chloride is dissolved in the water, the salt dissociates into ions almost completely, and the conductivity is greatly increased. Suppose we hold a bead of salt on a platinum wire in a flame, then the salt volatilises and the flame is filled with its vapour, and, just as with the water, the conductivity is enormously increased.

With the long flame and an electrode at each end, we can try the effect on the current of putting salt in different parts of the flame between the electrodes. In this way it is easy to show that the current is practically unchanged, unless the salt vapour is put in close to the negative electrode, but in that case it produces a very great increase in the current. This confirms the conclusion that nearly all the resistance to the passage of the current is situated close to the negative electrode. When the salt is put in anywhere it diminishes the resistance there to a small fraction of its value, but it is only close to the negative electrode that the diminution in the total resistance is appreciable. If we measure the potential difference between two points in the flame away from the electrodes, and then put salt vapour in the flame between them, we find that the P.D. drops to a small fraction of its value, although the current is the same as before. This shows clearly that the salt vapour greatly increases the conductivity wherever it is put in.

When some salt is put on the negative electrode, the sudden drop in potential there almost disappears, and we get a nearly uniform potential gradient from one electrode to the other, so that now the resistance is nearly uniformly distributed along the flame. If now salt vapour be put in anywhere between the electrodes, the current is increased. If, for example, we fill half the length of the flame with salt vapour, we nearly double the current.

When salt is put on one electrode, the flame can be used as a rectifier for an alternating current, for when the salted electrode is negative the resistance of the flame is much smaller than when it is positive.

Measurements have been made of the conductivities of a number of alkali salt vapours in a current of air flowing along a platinum tube heated in a gas furnace. An electrode was fixed along the axis of the tube, and the current from it through the salt vapour to the surrounding tube was measured with a galvanometer. It was found that at temperatures above 1400° C., and with electromotive forces of about 1000 volts, the current was proportional to the amount of salt passing through the tube, and for different salts in equal quantities inversely proportional to the electrochemical equivalent of the salt. This shows that the quantity of electricity per molecule of salt is the same for all salts. It was also found that the quantity of electricity carried per molecule was equal to that carried per molecule when a solution of salt in water is electrolysed. It appears, therefore, that the laws of electrolysis discovered by Faraday for liquids apply also to salts in the state of vapour.

When a molecule of salt like sodium chloride dissociates into two ions in water, the sodium atom forms the positive ion and the chlorine atom the negative ion, and when a current is passed through the solution the sodium is attracted to the negative electrode and the chlorine goes to the positive electrode. We might expect the same thing to happen when a current is passed through the salt vapour in a flame. If we put two wires in the flame, and put some sodium salt on one, and then connect them to an induction coil, and pass a discharge from the salted one to the other, we find that the yellow sodium vapour appears at it when it is the negative pole, but not when it is positive. This shows that in the flame the positive ions of the salt vapour contain the metal just as they do in solutions. The negative ions, however, do not appear to be the same in flames as in solutions. In flames the very high velocity of the negative ions indicates that they are the electrons the properties of which have been investigated in vacuum tubes by Sir William Crookes and Sir Joseph Thomson. The positive ion, then, is an atom or molecule, while the negative ion is an electron the mass of which is several thousand times smaller. This is the explanation of the fact that the negative ions move 100 times more quickly than the positive ions.

HEAT-TRANSMISSION IN STEAM BOILERS.[1]

AT the present time the relations between the various factors that govern the flow of heat from a gaseous fluid into a metal surface with which it is in contact remain extremely obscure.

The formulæ in general use, which express in a concrete manner the views of engineers upon the subject, are of a purely empirical character and without theoretical

[1] Abstract of paper on "Laws of Heat and Transmission deduced from Experiment," by Prof. J. T. Nicolson, read before the Junior Institution of Engineers.

foundation. They all agree in attributing to the greater or smaller temperature-differences between gas and wall which occur in practice the higher or lower rates of heat transference which are met with, and in ignoring any effect upon that rate which may be produced by a variation of the speed of gas flow.

In 1874 Prof. Osborne Reynolds brought before the Literary and Philosophical Society of Manchester a paper entitled "The Extent and Action of the Heating Surface of Steam Boilers." In this paper, starting with the laws then recently discovered of the internal diffusion of fluids, he endeavoured to deduce from theoretical considerations the laws for the transmission of heat. His formula expressing this law is

$$H=(A+B\rho u)(T-\theta),$$

where A and B are constants, ρ, u, and T are the density, speed and temperature of the fluid, and θ is the temperature of the wall. For small values of u this becomes Newton's law of cooling; for large values the A-term is less important, and the formula becomes one which is applicable to steam boilers.

No further investigation of the subject was made until 1897, when Dr. T. E. Stanton made a series of experiments to test the truth of the views advanced. He found that the amount of heat transferred when *water* forms both the heat-conveying and heat-receiving medium is nearly proportional to the speed of flow, and that Osborne Reynolds's views were abundantly confirmed.

In 1899 Prof. Perry, in his book on the "Steam Engine," wrote a chapter on "How Fluids give up Heat and Momentum"; and, in discussing the efficiency of steam boilers, he finally remarked:—"It seems to me that when a good scrubbing action is established on both sides of the metal there ought to be at least ten times, and may be more than 100 times, as rapid an evaporation per square foot of heating surface as has yet been obtained in any boiler."

There is no record that up to the present time any British or Continental engineer has paid serious attention to these pregnant words, or has realised the immense possibilities which lie behind Prof. Osborne Reynolds's statements, should their truth be experimentally demonstrated.

The author attached so much importance to the matter that, in 1898, after reading Dr. Stanton's paper, he constructed an apparatus in his laboratory at the McGill University for the purpose of further study. His removal to Manchester in 1899, and his subsequent occupation by other work, had, however, prevented his further taking up the question until 1905.

Since that time three series of experiments have been made by himself, and one series by his pupil, Mr. H. P. Jordan, on the subject.

The apparatus used was usually of a fairly simple type, consisting of two long concentric tubes through which (*a*) warm compressed air and cold water, (*b*) superheated steam and cold compressed air, (*c*) superheated steam and cold water, and (*d*) products of combustion of coal and boiling water, were passed in opposite directions through the two pipes at various rates of speed.

An analysis of all these results, together with those of Petiet and Geoffroy, and Henry and Marié upon locomotive boilers, have led to the formula:—

$$Q=\left[\frac{\phi}{200}+\frac{\sqrt{\phi}}{40}\left(1+\frac{1}{m_1}\right)\rho_1 u_1\right]\left(T-\theta\right)$$

for the heat flow Q in B.Th.U. per sq. ft. per hour when:

T = temperature of gas (°F.),
θ = ,, wall (°F.),
ρ_1 = density of gas (lbs./cu.ft.),
u_1 = speed of gas flow (feet/sec.),
$\phi = \frac{1}{2}(T+\theta)$ = mean film-temperature,
m_1 = hydraulic mean depth of gas-flue (inches).

According to this formula, the rate of heat transfer *for a given temperature-difference* between gas and wall depends upon (*a*) the mass-flow of the gas, lb. per sec. per sq. ft. of flue-section; (*b*) the average temperature of gas and wall; and (*c*) the smallness of bore of the tube or width of channel conveying the gas.

The usual rate of heat transfer in steam boilers is (from 3 to 10) about 5 B.Th.U. per sq. ft. per hour per degree difference of gas and water (*i.e.* wall) temperature. In the author's experimental apparatus he succeeded in transmitting more than 300 B.Th.U. per sq. ft. per hour per degree difference, *although the air was only about* 30° F. *hotter* than the water.

In an experimental boiler he was able also to produce evaporations at the rate of from 30 lb. to 50 lb. of steam (as from and at 212° F.) per sq. ft. of *indirect* heating surface per hour when the gas temperature was at about 1500° F. and the water at 300° F. In both cases this high rate of heat transference was principally due to the very high gas velocities employed. These varied from 300 to 550 feet per second, whereas in ordinary boiler practice it never exceeds 150, and is usually from 10 to 30 feet per second.

The way in which the new experimental facts should influence practice in steam generation may be stated as follows.—

In the first place, since the amount of heat that can be transmitted for a given temperature difference is almost directly proportional to the speed of the gases, a reduction of area of the heating surface in steam boilers—to one-half, one-quarter, or even one-tenth of what is now usual—can be made without the chimney temperatures being raised or the efficiency lowered to any material extent. Or, otherwise, if the surface be kept the same, but the cross-sectional area through the flues be reduced, in order to obtain the necessary high gas speed, a very much lower chimney temperature and correspondingly higher efficiency can be secured than is now available.

Accordingly, drafts of 10 or 20 inches of water gauge, induced by fans, should always be employed for really economical working.

In the case of boilers of usual construction, in which the gases pass through flues or tubes and leave the boiler at a point where the temperature on the other side of the heating surface is that corresponding to the steam pressure, a limit will soon be reached as to the amount of draft-suction which can be employed, and this from one or other of two causes:—

(*a*) Whilst the fire need not be forced, even when these high drafts are used, to a greater extent than that now usual, the high speed of entry of the glowing gas at the furnace end of the tubes will cause leakage, and some other construction for such purposes than that now generally employed must be sought for.

(*b*) The fall in temperature of the chimney gases due to the small flue-section and accompanying high speed will, as intimated above, certainly provide an additional amount of evaporation which can be drawn upon to cover the extra power required for the fans, but the margin between present chimney temperatures and the lowest which are possible in ordinary designs of boiler under the above conditions is not very great when the steam temperatures are from 350° F. to 400° F. A limit will therefore soon be reached beyond which it will not pay to pass. The author, after a careful investigation of costs and running expenses, has good reason to believe that this limit of draft-pressure is, even for the ordinary type of boiler, much higher than that now in common use.

In the second place, since the author's experiments have shown that with a counter-current flow of gas and water it is possible to lower the gas temperature (at such high speeds as he used) to within 20° F. of that of the entering feed, we have here the evidence that chimney temperatures of 100° F. to 150° F. can be reached and maintained provided only high gas and water speeds are resorted to and the boiler is designed on the economiser principle, with strict attention to counter-current methods of flow.

Now such a low chimney temperature as this corresponds to a transmission efficiency of more than 95 per cent.! The margin of additional evaporation available for the supply of the fan-power is, accordingly, so much greater than is required that not only can higher economies be obtained on this system than have hitherto been thought possible, but they can be effected with boilers having smaller areas of heating surface, smaller total volumes, smaller floor areas, lighter weights, and lower first costs than those we ordinarily employ.

Finally, since the enhanced evaporative efficiency of the

heating surface due to high speed, and its correspondingly reduced area, renders it possible economically to line that part of the surface nearest to the furnace with refractory material, and so to secure a non-water-cooled or reverberatory chamber in which the combustion processes may be perfectly completed, any special need for skilful firing is dispensed with, and, by providing plenty of air and an ample mixing space behind the bridge, excellent results, and an entire absence of smoke, may be obtained without special care.

Such brick-lined combustion chambers cannot now be afforded next the furnace in ordinary boilers, for the heating surface at this point is almost all that the boiler has of even *moderately* good evaporative power, and it cannot be sacrificed, as convective heating surface, to be lined with a protective coating for the purposes of a combustion chamber.

Nor is this all. Any lack of high furnace temperature accompanying such air excess can so easily be made up for by the additional gas speed that nearly the whole heat-value of the coal can still be passed into the water, even when the flue gases are relatively cool, without any undue extension of the heating surface being found necessary. We see also that the extra quantities of air just mentioned may be admitted to the furnace without encountering the evil results which usually follow such a course. For, as practically all the heat is extracted from the gaseous products before they reach the chimney when this high-speed counter-current method of working is adopted, it matters but little to what extent they are diluted.

Thus the proposed new method of working, using both high-speed and counter-current gas and water flow, appears to be capable of introducing several features of radical improvement into the present practice of steam-boiler construction and working.

The author believes that some such features must shortly be incorporated in boiler design if the steam engine is to retain the preeminence it has so long enjoyed in the economical production of power.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

AMONG the courses of lectures announced by the University of Göttingen in the Bulletin of the American Mathematical Society, we notice the entry:—"By Prof. L. Prandtl: Theory of aëronautics, four hours."

Science announces that the passage of the Legislative Appropriation Bill carrying 196,400*l.* for the University of Kansas, gives the University all it asked, except an appropriation for a dormitory. From the same source we learn that by the will of Ellen A. Kendall, her residuary estate is given to Wellesley College to found a professorship bearing her name. It is provided that if the fund exceeds 12,000*l.* the income of the excess shall be used to aid worthy students.

THE *Lancet* states that one friend of McGill University has recently promised to give 20,000*l.* to the University as soon as 100,000*l.* has been raised elsewhere, and another has presented the governors of the institution with an unconditional gift of 5000*l.* The above announcements were made at a recent meeting of the corporation of the University, and as the authorities have now in hand about 20,000*l.*, it was decided for the present to leave in abeyance the plans for obtaining the 400,000*l.* which the institution needs, and to concentrate all possible efforts towards securing the other 80,000*l.* necessary before the new 20,000*l.* donation can be accepted.

WE have received a copy of the March issue of *The Record*, the magazine of the South-Western Polytechnic Institute, Chelsea. In addition to the interesting chronicle of the doings of the various societies in connection with the institute, the magazine contains several articles by old students and others on aspects of the engineering profession. An illustrated account is given of a recently acquired 50-ton testing machine in the mechanical engineering laboratory, and a compound steam engine provided by the London County Council is included. These additions are good instances of the satisfactory equipment with which technical institutions of London are now able to instruct their students in the practical requirements of industrial enterprise.

THE annual meeting of the Swanley Horticultural College (for Women) was held on March 24. The chairman, Sir John Cockburn, in moving the adoption of the report and balance-sheet, laid stress on the admirable work done by the college in meeting the two great requirements of the day, viz. rural education and the higher education of women. Mr. C. Bathurst, in seconding the resolution, directed attention to the growing demand on the part of local educational authorities for teachers qualified to give instruction in nature-study and school gardening in both elementary and secondary schools, and the increasing usefulness of Swanley in meeting this demand. Short courses of instruction upon gardening and other country occupations will be given at the college from May 6 to June 15 and from June 18 to July 27. There will also be a nature-study course from July 31 to August 14.

As technical education in India is about to receive serious consideration, attention is directed in an article in *Indian Engineering* for February 20 to certain causes of failure in the past. The original scheme of education in India seems to have been instituted for the principal purpose of providing a supply of Indian clerks having a knowledge of English. As the result of fifty years of this policy it is now found that higher education is pursued with too exclusive a view to entering Government service, and its scope is thus unduly limited. Again, difficult work requires expert workers, and it is to be hoped that these will be forthcoming, and that they will have a freer hand in dealing with technical education problems than has hitherto been the case in the Indian educational administration. Steps should be taken to secure that expert educationists will be in a majority, and that their reports will not require to be made through alien departments. The example of Japan shows what is possible in Eastern countries, but Japan was initially guided by men of educational experience and scientific knowledge.

THE issue of the *Oxford and Cambridge Review* for the Lent term provides a varied table of contents. In an article on some defects in the curriculum of the public schools and a suggested remedy, Mr. A. R. Gidney directs attention to certain resolutions adopted at last year's conference of headmasters, and the decision to appoint a committee to consider a scheme of studies for boys from the ages of nine to sixteen or thereabout. Against the present scheme of studies, says Mr. Gidney, three indictments may be brought:—it is surcharged with languages; it recognises inadequately the bent of individual boys; and it fails to arouse an intellectual interest in the majority of boys. Having dealt with the congested state of the present curriculum, the writer wisely insists that a selection of subjects must be made, and that in making it it must be remembered that the majority of boys have a greater ability for one class of studies than another, and that this ability, though innate, does not manifest itself usually with any clearness until a particular epoch in the boy's life. Most authorities will agree with these conclusions, but many will consider that Mr. Gidney gives too little prominence to the need for practical studies of several kinds in the scheme of education he outlines. Mr. Leonard Hill, F.R.S., contributes an article on oxygen for athletes, and after explaining and summarising some of the researches of Dr. John Haldane, Dr. Pembrey, Prof. Zuntz, Mr. Flack, himself, and other workers in connection with the inhalation of oxygen, he concludes his essay by remarking that he is "indifferent whether oxygen is used by athletes or not; if they choose to try they will soon find out whether the advantage gained is worth the trouble and expense." Mr. Hill "is content with the knowledge he has gained, that oxygen inhalation combined with exercise is a potent method of treatment in various pathological states." Mr. M. M. Pattison Muir writes on the abuse of the word "scientific."

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, January 14.—"On the Depression of the Filament of Maximum Velocity in a Stream flowing through an Open Channel." By A. H. **Gibson.** Communicated by Prof. J. E. Petavel, F.R.S.

In a stream flowing through an open channel the filament of maximum velocity is not, as might be expected, in the surface and in the centre of the stream, but is usually at some distance below the surface. No satisfactory explanation of the reason for this has hitherto been given. In this paper the phenomenon is attributed to the effect of transverse currents which sweep up each side of the stream, along the surface towards the centre, down near the centre, and outwards near the bottom. These currents, the existence of which may be foretold from theoretical considerations, and which have been observed by the author in a number of streams and open channels, spread a layer of slowly moving water over the surface of the stream, and so depress the filament of maximum velocity.

This explanation also accounts for several subsidiary phenomena which are observed in river gauging, such as the effect of the roughness of the sides and of the bottom, and of the ratio of breadth to depth on the depth of this filament.

January 21.—"The Leakage of Helium from Radio-active Minerals." By the Hon. R. J. **Strutt**, F.R.S.

In a paper published in Roy. Soc. Proc., A, vol. lxxxi. (1908), p. 272, the author showed that phosphatised bones and similar materials were notably radio-active, and that helium could be detected in them. The quantity of helium found was not, however, uniformly greater in the geologically older materials than in younger ones of equal activity. This was hypothetically attributed to escape of helium in certain cases. The author desired, if possible, to observe directly the escape of helium from radio-active minerals at the ordinary temperature.

It was found that after a radio-active mineral had been powdered, helium was evolved from it, rapidly at first, then at a diminishing rate. The following observations illustrate this.

A quantity (337 grams) of monazite from the Transvaal was powdered and passed through a wire gauze sieve of 120 threads to the inch. This took about one hour. Immediately afterwards it was put in a bottle and the air pumped out. The rate of evolution of helium in cubic millimetres per day per kilo. of material was as follows:—

Time (days)	Rate
0·031	261
0·59	76·6
1·6	17·1
2·6	12·3
4·6	9·57
10·6	4·38
33·0	1·14

The whole quantity which has escaped while the mineral has been under observation is but an insignificant fraction (probably less than a 500th [1]) of the whole quantity present.

Moss (Roy. Dub. Soc. Trans., vol. viii., p. 153) has observed that quantities up to 1 per cent. of the helium contained in a mineral can be liberated by grinding in a vacuum. The present observations show that this is but the first rapid stage of a long-continued leakage of helium from the newly created surfaces. The view that heat generated in grinding is the important factor appears untenable, for in that case escape of helium should cease on cooling.

It was found that pieces from the same stock of monazite, about the size of a lump of sugar, which had not been fractured since they came into the possession of the author two years ago, evolved helium at the rate of 0·002 c.mm. per kilo. of material per diem.

This rate, though quite insignificant in comparison with that exhibited by the powdered material, is much in excess of the probable rate of generation of helium by radio-active change. It follows that the present stores of helium could never have been accumulated had the present rate of evolution prevailed throughout the life-history of the mineral.

With the view of testing a mineral more nearly in its natural condition, experiments were made on thorianite, which occurs in gravels, in detached cubic crystals, washed out of their original matrix. This, too, showed a considerable leakage of helium (0·069 c.mm. per kilo. per diem).

Under laboratory conditions the rate of escape of helium from minerals always far exceeds the rate of production by radio-active change. Therefore the conditions under which the life of the minerals has been mainly passed, deep down in the earth, where atmospheric agencies have no place, must be supposed more favourable to retention of helium, for otherwise the present accumulation could never have been formed. The observations here recorded leave little room for surprise that fossilised bones and other materials do not always contain as much helium as would be expected from their radio-activity and geological age.

Geological Society, March 10.—Prof. W. J. Sollas, F.R.S., president, in the chair.—Some notes on the neighbourhood of the Victoria Falls (Rhodesia): T. **Codrington.** An account is given of the way in which the basalt lies in the valley of the Zambezi below and above the Victoria Falls, and how this determines the features of the river is pointed out. The basalt through which the Batoka Gorge has been cut appears in the course of the Zambezi for two miles above the Victoria Falls, causing rapids. It then disappears, and the river above flows quietly between alluvial flats for five miles, the basalt being traceable here and there below the water until above Candahar Island it again rises and constitutes the bed of the river from bank to bank, causing rapids. The discovery of stone implements and artificially worked stones in the gravel and the bed of the Maramba is noted. The majority of flakes and flaked stones having no trace of design over those that can be considered as implements suggests that the manufacture of stone tools on a large scale was here carried on for use in the sand-covered country on both sides of the Zambezi, where there is no stone. There appears to be no evidence as to the age of the implements found near the Zambezi.—A contribution to the petrography of the New Red Sandstone in the west of England: H. H. **Thomas.** The paper is supplementary to one dealing with the mineralogical composition of the pebble-bed. A list of minerals identified, and tables showing their distribution, are given. It is suggested that anatase occurs both as detrital crystals and as crystalline groups formed in the rocks since their deposition. The forms presented by grains of staurolite, as well as certain crystals of tourmaline with an unusual habit, are described. It is recognised that the divisions of the New Red Sandstone, although linked together by a similarity of mineralogical composition, present differences indicative of variations in the source of supply and conditions of deposition. With regard to the vertical and horizontal distribution of minerals, staurolite is abundant in the Lower Breccias and Sandstones of the extreme south of Devon, but less plentiful northwards; garnet is present in all the New Red rocks of North Devon and Somerset, but in south and central Devon only occurs in the Lower Marls and in the Upper Marls and Sandstones.

Physical Society, March 12.—Dr. C. Chree, F.R.S., president, in the chair.—The effect of radiations on the brush discharge: A. E. **Garrett.** Willows and Peck in 1905 found that radium radiations can extinguish a brush discharge produced by a Wimshurst machine when the gap is greater than 3–4 cm. These experiments show that the phenomena can be produced by an induction coil giving a 6-inch spark. The observation that the β rays are responsible for the effects produced is confirmed. The effect of the nature of the anode on the sensitivity of the positive brush is dealt with. It has been found that the sensitive nature of the brush depends upon the oscillatory nature of the discharge, and probably a side discharge takes place when the brush is extinguished by the radium.—Pirani's method of measuring the self-inductance of a

[1] This sample of monazite was very poor in helium, containing only $\frac{1}{10}$ c.c. per gramme.

coil: A. E. **Snow.** In this method the coil the self-inductance L of which is to be measured is joined in series with a condenser of capacity C, and the combination forms one arm of a Wheatstone's bridge. The condenser is shunted by a non-inductive resistance *r*. The result $L=Cr^2$, whence the value found for L is independent of the inductance of the galvanometer, has been proved for the case in which the discharge of the condenser is continuous. In this paper the case in which the discharge of the condenser is oscillatory is dealt with, the applied E.M.F. being constant. It is shown that the discharge of the condenser is of the same nature as that through the galvanometer. In the case of an oscillatory discharge of the condenser the value found for the inductance of the coil is not affected by the inductance of the galvanometer. If the same method is applied to the case of an alternating E.M.F., a result is obtained which involves the inductance of the telephone used to indicate the current. From general considerations this can be shown to be impossible. The method used in the case of a constant E.M.F., therefore, is not available for the investigation of the case in which the E.M.F. is alternating.—Exhibition of a high-potential primary battery: W. S. **Tucker.** The object of the battery is to maintain at known potentials such conductors as the needle of the quadrant electrometer, for charging condensers in capacity and insulation tests, and so on. It is composed of a large number of elements in series, the elements consisting of carbon and pure zinc with a nearly saturated solution of calcium chloride as electrolyte. It is found possible to obtain 1·02 volts per element, so that a total of more than 900 volts is given. Since the terminals are well insulated, a very steady voltage is obtained, and this has been kept within one-tenth per cent. variation for two hours and 1 per cent. for half a day, the temperature of the room remaining steady. The battery has fitted to it an arrangement whereby any desired voltage from that of one to that of all the cells can be obtained by steps of one cell. A special feature of the battery is its careful insulation.—The least moment of inertia of an angle-bar section: H. S. **Rowell.**

Linnean Society, March 18.—Dr. D. H. Scott, F.R.S., president, in the chair.—The "dry-rot" of potatoes: Miss Sibyl **Longman.** The author pointed out, as the result of her researches, that the disease of the potato tuber, known as "dry-rot"—due to the fungus *Fusarium Solani*—is not necessarily preceded by "wet-rot," but may be set up in sound tubers by inoculation with spores or mycelium of *Fusarium Solani*, which species is not a parasite of the resting tuber only; it may also attack and kill the shoots of potato plants. The fungus, which probably exists as a widely distributed saprophyte in the soil, infects the growing potato plant *viâ* the root; it also spreads from tuber to tuber during storage, and diseased tubers may produce diseased plants. Heat sterilisation of the resting potato tuber, with respect to *Fusarium Solani*, is impracticable, for the death-temperature of the fungus is higher than that of the potato. A pycnidial stage occurs in the life-history of *Fusarium Solani*, which should therefore be placed in the highest group of the Fungi Imperfecti, the Sphæropsidaceæ, and not, as is the case at present, in the Hyphomycetes.—The structure and affinities of *Davidia involucrata*, Baill.: A. S. **Horne.** The paper deals with the structure and affinities of a genus referred to the natural orders Combretaceæ, Cornaceæ, and Hamamelidaceæ by various authorities, in the light of original observations carried out under the direction of Prof. J. B. Farmer, upon material brought by Mr. E. H. Wilson from Szechuen in 1904. Evidence is advanced in favour of interpreting the inflorescence as consisting of a number of congenitally fused, apetalous, multi-staminate male flowers, or of male and in addition a single obliquely situated, apetalous, hermaphrodite flower with epigynous stamens *arranged in series*. From a detailed study of the flower, ovary, ovule, and seed, the author is inclined to believe that Davidia is distantly related to Alangium and Nyssa, and still more distantly related to the Araliaceæ; that the genus occupies a somewhat isolated position owing to having pursued an independent course of development from the plexus of primitive groups, which included the ancestral forms of the Araliaceæ, Nysseæ, and Alangieæ.

EDINBURGH.

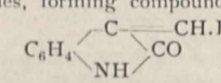
Royal Society, March 1.—Dr. R. H. Traquair, F.R.S., vice-president, in the chair.—The systematic motion of the stars, second paper: Prof. **Dyson.** Following up a previous paper on the subject, the author, by application of a statistical method, found that the two streams were moving with velocities which were in the ratio of 2 to 3. The stars belonging to the two streams did not appear to have any other distinguishing characteristics.—Preliminary note on *Cynomacrurus Piriei*, a new deep-sea fish discovered by the Scottish National Antarctic Expedition: Prof. **Dollo.** This new fish, named after Dr. Pirie, surgeon and geologist to the *Scotia*, belonged to the Macruridæ, a family closely allied to the cod. The existence of Macruridæ within the Arctic Circle had been known since 1837, when Sven Lovén recorded *Macrurus burglax* from Hammerfest, Finmark. In 1899 Prof. Dollo recorded the first macrurid from the Antarctic, namely, the new species *Nematoneurus lecontii*, brought home by the *Belgica*. The new species now described differs generically from these. It was obtained in lat. 71° 50′ S., long. 23° 30′ W., at a depth of 2102 fathoms.

March 15.—Dr. Traquair, F.R.S., vice-president, in the chair.—The glacial deposits of western Carnarvonshire: Dr. T. J. **Jehu.** The Lleyn promontory lay outside the paths followed by the native glaciers. Hence, instead of the lowest Boulder Clay of the district east of Snowdonia, there is a "rock rubble" or "head" which underlies all the drift deposits, and is the result of subaërial waste under severe climatic conditions. It is succeeded by (1) a Lower Boulder Clay with northern erratics and shells; (2) sands and gravels; (3) an Upper Boulder Clay with northern erratics and shells. The Lower Boulder Clay, which is the most widely spread of all these deposits, is the product of a *mer-de-glace* coming from the north, which overwhelmed Lleyn as far east as a line running from Carnarvon to Cardigan Bay, in the neighbourhood of Pwllheli. The sands and gravels were accumulated during a retreat of the ice, while the Upper Boulder Clay marks a re-advance. So far as Lleyn is concerned, the two Boulder Clays might be regarded as the product of one *mer-de-glace* which was subject to considerable oscillations, but a review of the Irish Sea basin as a whole renders it more probable that they are the products of the ice-sheets of two Glacial epochs separated by an inter-Glacial epoch.—The Glenboig fireclay: its halloysite and sideroplesite: Prof. J. W. **Gregory.** Evidence was adduced to show that this fireclay was laid down in a wide lagoon in the beginning of the Millstone Grit period. It contains lenticular crystals of sideroplesite, which have been built up by zonal deposition around rhombohedra, which probably crystallised in the water of the lagoon. The clay substance which forms the base of the fireclay is isotropic, and is referred to the mineral halloysite. The clay contains no kaolinite.—Tuesite, a Scottish variety of halloysite: Prof. **Gregory.** Tuesite was founded as a mineral species by Thompson in 1836 for material described as occurring in beds in the New Red Sandstone on the banks of the Tweed, and has been identified with kaolinite. The absence of china clay from Scotland has been used as a strong argument in favour of the pneumatolitic origin of that material, and the reported nature and occurrence of tuesite would have been inconsistent with that origin. Re-examination of the material shows, however, that the tuesite occurs as an alteration product in a volcanic neck; it is not kaolinite, but halloysite, and its formation is consistent with the deep-seated origin of the great china-clay masses found in many parts of the world.

PARIS.

Academy of Sciences, March 15.—M. Bouchard in the chair.—Systems of homogeneous differential equations: Gaston **Darboux.**—The flow of rivers: Bouquet **de la Grye.** It is generally assumed in works on hydraulics that in water in motion under the action of gravity the elementary strips move in a straight line, the flow being expressed as a time function of the fall. This does not correspond with practice; the motion is in curved lines. By applying the principle of least action, it is found that the strips of liquid would have a tendency to turn to the

side where the friction is a minimum.—The magneto-kathode rays: M. **Gouy.** The resistance of rarefied gas under the action of the magneto-kathode rays has been measured, and found to be much smaller than in the absence of the rays.—Remarks by M. B. **Baillaud** on the twentieth *Bulletin de l'Observatoire de Besançon.*—Comparison of the lines of the spectrum of the electric arc and of the sun. Pressure of the reversing layer in the solar atmosphere: Ch. **Fabry** and H. **Buisson.** The comparison has been made by the interference methods previously described by the authors, and only the finest lines in the spectrum were utilised. The numerical results accord with those of Jewell, and are not completely explained by the theory of displacement by pressure. Assuming the average displacement to be a pressure effect, it results that in the region of the solar atmosphere where the iron lines are absorbed the pressure is between 5 and 6 atmospheres.—Certain triple orthogonal systems: J. **Haag.**—The singularities of analytical functions beyond the circle of convergence: Paul **Dienes.**—The fundamental equations for the experimental study of aëroplanes: D. **Drzewiecki.**—Measurements of the coefficient of resistance of air carried out by means of experiments made on an aëroplane: A. **Etévé.** There is a large discrepancy between the coefficient k of the resistance of the air as determined by physicists and by experiments with aëroplanes, the latter number being about ten times the former. It is shown that this discrepancy is largely due to an unjustifiable assumption made in calculating k from the aëroplane results.—The decomposition of water by radium salts: A. **Debierne.** The author's experiments do not confirm the loss of the power to produce hydrogen and oxygen by a radium salt, recently announced by Sir William Ramsay. The amounts of hydrogen and oxygen evolved by a gram of radium have been found to be regular and of the order of 13 c.c. per day. Some of this is shown to be due to the action of the β and γ rays.—The chemical action of the penetrating rays of radium on water: Miroslaw **Kernbaum.** By the action of the β and γ rays on distilled water for one month, 200 cubic mm. of gas was obtained, which on analysis proved to be hydrogen. The residual water responded to the potassium iodide and starch test, from which the conclusion is drawn that hydrogen peroxide is formed simultaneously with hydrogen.—The question of the emission and absorption of incompletely polarised light in a magnetic field and on the Zeeman phenomenon in fluted spectra: Jean **Becquerel.**—The utility of the graphical method in the study of ancient musical instruments: M. **Marage.**—The electromotive forces of magnetisation: V. **Posejpal.** The electromotive force of a metallic thermocouple changes when the neighbourhood of the junction becomes the seat of an intense magnetic field. This change is not related to the presence of a ferromagnetic metal, and is independent of the direction of the field. The electromotive force thus produced increases with the strength of the field, but not proportionally.—The cryoscopy of colloids: Jacques **Duclaux.** The measurements of the osmotic pressure (P) and lowering of the freezing point (A) of colloidal solutions of the hydrates of iron and thorium satisfied the theoretical relation $P = 12{\cdot}2.\Delta$.—A new isomeride of indigo: A. **Wahl** and P. **Bayard.** Oxindol (the lactam of *o*-amidophenylacetic acid) reacts with aromatic aldehydes, forming compounds of the type



for which the name iso-indogenides is proposed.—The condensation of the mesoxalic esters with phenol ethers: A. **Guyot** and G. **Estéva.**—The action of caustic potash on borneol, camphor, and isoborneol: racemic campholic acid: Marcel **Guerbet.** The production of campholic acid by the interaction of borneol and anhydrous caustic potash has been described in an earlier paper. The only other substance obtained from the reaction product was thought to be unaltered borneol, but this has since been found to contain a considerable quantity of camphor.—The genesis and optical properties of the neogenic felspar of the sediments of the Paris basin: F. **Grandjean.**—The nitrification of soils: MM. **Pouget** and **Guiraud.**—The influence of mineral manures on some Cyperaceæ: J. B. **Gèze.**—The manostatic centres and the physiological treatment of arteriosclerosis: P. **Bonnier.**—Contribution to the study of hypo-anæsthetics: A. **Brissemoret** and J. **Chevalier.**—A parasitic microsporidian of *Frenzelina conformis*: L. **Léger** and O. **Duboscq.**—The Mosquero spider: Léon **Diguet.**—The Mosquero spider: Eugène **Simon.**—Extension of the Coal-measures under the Trias and Jurassic strata in the basin of Alais (Gard): G. **Fabre.**—The earthquakes of December 28, 1908, and January 23, 1909: D. **Eginitis.**—A luminous phenomenon observed at Brest on the night of February 22: Thierry **d'Argenlieu.**

March 22.—M. Bouchard in the chair.—Systems of homogeneous differential equations: Gaston **Darboux.**—Contribution to the search for planets beyond Neptune: A. **Gaillot.**—M. Termier was elected a member of the section of mineralogy in the place of the late M. A. Gaudry.—The spectrum of the comet 1908*c* (Morehouse): A. **de la Baume-Pluvinel** and F. **Baldet.** A continuation of work already published. In the later photographs a greater dispersion was obtained (10·9 mm. between F and H), and special arrangements were made to secure the yellow and ultra-violet ends of the spectrum. The greater part of the lines in the spectrum of this comet is furnished by a single gas, presenting a system of bands the heads of which follow the law of Deslandres. These bands cannot be identified with any known spectrum.—Another method of dealing with the problem of the integration of partial differential equations of the second order: E. **Goursat.**—An application of the functional calculus to the study of linear partial differential equations of the third order and hyperbolic type: R. **d'Adhémar.**—The stability and displacement of equilibrium: C. **Raveau.**—Particular solutions of the equation $\frac{\partial^2\phi}{\partial x^2} - \frac{\partial\phi}{\partial t} = 0$: Henri **Larose.**—Resonator sparks. Their spectroscopic analysis: G. A. **Hemsalech** and A. **Zimmern.** From the point of view of spectroscopic analysis, there is a great difference of constitution between the best long resonance spark and the short spark. The former is the capacity spark; the air lines predominating in the latter, there is a predominance of bands, the air lines being absent.—The normal and abnormal Zeeman phenomenon in vapour spectra. Reply to the note of M. J. Becquerel: A. **Dufour.**—The magnetic properties of some iron compounds: M. **Wologdine.** Results of the determination of the temperatures of magnetic transformations of magnetite, pyrrhotine, iron carbide, carbide of iron and tungsten, franklinite and phosphide of iron.—The approximation of black bodies used as receivers: C. **Féry.** A comparison of the behaviour of platinum black and lampblack as absorbents. The differences are shown graphically, and the conclusion is drawn that a re-determination of the coefficient in Stefan's law is necessary.—Contribution to the study of radiation: G. **Millochau.** The researches of the author, in collaboration with M. Féry, have led to a value of 9·5 for Stefan's coefficient, whilst Kurlbaum found in 1898 5·25 for the same coefficient and Scheiner (1908) 4·78. The causes of this divergence are discussed in the present paper, and it is shown that the actinometers in current use, in which the receiver is a thermometer covered with black, do not measure the absolute value of the radiation which they receive, but only a part of it. To obtain an absolute actinometer it must be furnished with a receiver really possessing the properties of an integral radiator.—The phosphorescence and combustion flames of sulphur: L. **Bloch.** The phosphorescence of sulphur is accompanied by the formation of ozone, and this in larger quantity than with phosphorus. This production is the more remarkable in that it takes place at a temperature (200°–250°) generally indicated as causing the destruction of ozone. At about 360° C. the blue flame of sulphur appears, and this flame is entirely deprived of electrical conductivity.—The experimental study of the coefficient of distribution and its application to the estimation of the volatile acids in wines: Philippe **Malvezin.**—A new method of preparation of the β-halogen derivatives of naphthalene: G. **Darzens** and E. **Berger.** The sodium derivative of β-naphthol is treated in boiling toluene solution with the phosphorus halide, the corresponding chlorine or bromine

derivative of naphthalene being obtained. The best yield (55 per cent.) was obtained with phosphorus trichloride.—The function of magnesia in the transformation of saccharose at different temperatures: J. **Tribot.**—Biochemical researches on the development of anthocyanine in plants: R. **Combes.**—Study of the action of iron on wine: M. **Trillat.** In contact with iron or its salts, the production of aldehyde in wine is very rapid. The quantities produced are sufficient to precipitate the colouring matters of the wine.—The penetration of pulverised liquids into the respiratory tracts: M. **Cany.** The experiments were carried out on sheep which had inhaled arsenical water, and the results clearly showed that an increase in the normal amount of arsenic in the lungs was produced. It is necessary for the success of similar experiments that the drops should be of the smallest possible dimensions.—The skeleton of the posterior member of *Bradypus torquatus*: A. **Menegaux.**—The geology of the basin of Ogôoué: H. **Arsandaux.**—The age and the nature of the most recent folds of the interior reliefs of the eastern Tellian Atlas (Algeria): L. **Joleaud.**

CALCUTTA.

Asiatic Society of Bengal, March 3.—Studies in the experimental breeding of Indian cottons; an introductory note, part ii., on buds and branching: H. Martin **Leake.** The author has in hand observations on the effect of making crosses between types with the secondary branches sympodial and types with monopodial—observations of considerable importance, because early-flowering races are wanted for profitable cultivation in the neighbourhood of Cawnpur, and if the delaying of flowering, *i.e.* of forming main sympodial buds, should be dominant in crosses over the other condition, any other improvements brought in by the crossing would be rendered locally valueless. However, it was found that on crossing a monopodial by a sympodial, the offspring differed very slightly from the sympodial parent, though there might be some increase in number of secondary branches, and in the second (F_2) generation (the flower of the first generation being self-fertilised) the full sympodial type was dominant; but every proportion of sympodial and monopodial branches occurring on a single stem was found.—Notes on the theory of souls among the Malays of the Malay Peninsula: Dr. N. **Annandale.** A summary and revision of the author's views as expressed in an account of the animistic beliefs of the Patani Malays in "Fasciculi Malayenses."—Tamarisk manna: D. **Hooper.** Historical references to Gazangabin or Tamarisk manna in Persia and Arabia. Names and distribution of manna-yielding species of Tamarix in Asia. Chemical composition and properties of the manna.

DIARY OF SOCIETIES.

THURSDAY, APRIL 1.

ROYAL INSTITUTION, at 3.—Aërial Flight in Theory and Practice: Prof. G. H. Bryan, F.R.S.

LINNEAN SOCIETY, at 8.—The Amphipoda Hyperiidea of the *Scalark* Expedition to the Indian Ocean: A. O. Walker.—The Marine Mollusca from the same Expedition: J. Cosmo Melvill.—The Land and Freshwater Mollusca of the Seychelles Archipelago: E. R. Sykes.—On a Blind Prawn from the Sea of Galilee, *Typhlocaris galilea*, g. et sp. n.: Dr. W. T. Calman.

INSTITUTION OF ELECTRICAL ENGINEERS, at 8.—The Electrical System of the L.C.C. Tramways: J. H. Rider. (*Adjourned discussion.*)—The Theory and Application of Motor Converters: H. S. Hallo.

RÖNTGEN SOCIETY, at 8.15.—The Origin, History and Development of the X-Ray Tube: J. H. Gardiner.

FRIDAY, APRIL 2.

ROYAL INSTITUTION, at 9.—Electrical Striations: Sir J. J. Thomson, F.R.S.

CIVIL AND MECHANICAL ENGINEERS' SOCIETY, at 8.—Storms, and their Effect Upon the Sea Coast: Dr. J. S. Owens.

INSTITUTION OF CIVIL ENGINEERS, at 8.—Reinforced Concrete on Railways: W. E. R. Gurney.

GEOLOGISTS' ASSOCIATION, at 8.—The Valleys of the Cotswold Hills: Prof. W. M. Davis.—The Ancient Land of Egypt: Mary S. Johnston.

SATURDAY, APRIL 3.

ROYAL INSTITUTION, at 3.—Properties of Matter: Sir J. J. Thomson, F.R.S.

ESSEX FIELD CLUB (at Essex Museum of Natural History, Stratford), at 6.—The Head as an Index of Race: J. Gray.

MONDAY, APRIL 5.

ROYAL GEOGRAPHICAL SOCIETY, at 8.30.—The Scenery of Cuba, Haiti, and Jamaica: Sir Harry Johnston, G.C.M.G., K.C.B.

ROYAL SOCIETY OF ARTS, at 8.—Steam Turbines: G. G. Stoney.

SOCIETY OF CHEMICAL INDUSTRY, at 8.—Vapour Galvanising: S. Cowper Coles.—The Action of Sulphuric and Nitric Acids in the Nitration of Cellulose: C. N. Hake and M. Bell.

TUESDAY, APRIL 6.

ZOOLOGICAL SOCIETY, at 8.30.—Notes on an Ichthyosporidian causing a Fatal Disease in Sea-trout: Muriel Robertson.—A Collection of Fishes made by Dr. C. W. Andrews, F.R.S., at Christmas Island: C. Tate Regan.—Description of a New Form of Ratel (Mellivora) from Sierra Leone, with Notes upon the described African Forms of this Genus: R. I. Pocock.—On some New and Little-known Hesperidæ From Tropical West Africa: H. H. Druce.

ROYAL SOCIETY OF ARTS, at 4.30.—Ceylon: Its Industries and Material Progress: Hon. John Ferguson, C.M.G.

INSTITUTION OF CIVIL ENGINEERS, at 8.—*Further Discussion*: Construction and Wear of Roads: A. Mallock, F.R.S.—*Probable Paper*: The *New York Times* Building: C. T. Purdy.

WEDNESDAY, APRIL 7.

SOCIETY OF PUBLIC ANALYSTS, at 8.—The New Standards for Sewage Effluents: Dr. S. Rideal and W. T. Burgess.—The Determination of the 'Oxygen Absorbed' by Sewage and Effluents by a Modification of Kubel's Method: W. Carter.—A Note on Enkabang and Teglam Fats and Katio Oil, from Sarawak: C. J. Brooks.—The Composition of Milk: H. D. Richmond.

ROYAL ASTRONOMICAL SOCIETY, at 5.

GEOLOGICAL SOCIETY, at 8.

ENTOMOLOGICAL SOCIETY, at 8.—On Reciprocal Mimicry: Guy A. K. Marshall.

CONTENTS.