THURSDAY, FEBRUARY 18, 1909.

APPLIED PHYSIOLOGY OF THE CIRCULATION.

Therapeutics of the Circulation: Eight Lectures delivered in the Spring of 1905 in the Physiological Laboratory of the University of London. By Sir Lauder Brunton, Bart., F.R.S. Pp. xii+272. (London: John Murray, 1908.) Price 7*s.* 6*d.* net.

PERHAPS there is no department of the healing art in which the vivifying and reconstructing influence of physiology and of laboratory methods is more apparent than in that devoted to the study of disorders and diseases of the circulation. Of this position the recently published volume of lectures by Sir Lauder Brunton affords an excellent illustration, for all through its pages we see how physiology aids the physician, not only in clarifying his conceptions of clinical facts, but in applying and inspiring his treatment of circulatory ailments.

For the execution of the work the author possesses the happy combination of advantages derived from his early laboratory training under the celebrated Ludwig, from his life-long love of physiology, and from his extended experience as a clinical worker and teacher. It has been said that the physician is—or should be—a physiologist and something more; and that "something more" is the practical quality of applying, not only his pathological, but also his physiological data to the work of the hour. The dominance of that quality in the author's handling of the material of his lectures is a prominent feature of the volume.

In the earlier lectures we have an exposition of the physiology of the circulation. The clear and comprehensive description of the forces at work will be appreciated, not only by professional readers—whether physiologists or clinicians—but by those members of the community who take an interest in the study of physiological subjects. Moreover, even the medical reader fairly conversant with clinical work on the circulation may, by the perusal of these lectures, gain something in the clearness of his conception of the fundamentals presented by an author who has the gift of exposition and happy illustration.

In the first lecture we have a description of the parts played by the heart, the arteries, capillaries and veins, the vaso-motor system of nerves, and the accessory aids to the circulation furnished by the fasciæ and muscles; these and cognate topics are discussed under such headings as sleep of the heart, motor and peristaltic action of arteries, accessory muscles of the circulation, arterial tension or blood-pressure and its regulation, the influence of the muscular and splanchnic areas, depressor nerves, independent pulsation of veins, &c.

But the physiologist and pathologist will be more particularly attracted to that portion of the lecture which is devoted to the study of the point of origin and the conductivity of the impulse which culminates in the contraction of the ventricle, a subject which has, especially of late years, fascinated the pathologist as well as the physiologist—for it affords the key to the irregularity of the heart's action, and to the dissociation of the auricular and ventricular contraction. It is now some twenty-five years since Gaskell demonstrated the continuous track of the impulse from the venous sinus, in which it originates, to the auricle, and from the auricle to the ventricle; and the soundness of this physiological conclusion has since been confirmed by the work of Stanley Kent, W. His, jun., and more recent workers (such as Tawara and Keith), who have established the existence of a specialised muscular tissue possessing neuro-muscular properties, which forms the anatomical basis of the track followed by the impulse from the sinus to the ventricle. In introducing this subject the author cites the work of Romanes on the medusa, a polyp which is circumscribed by a bell-shaped piece of contractile protoplasm margined by a nervous gangliated chain and a fringe of mobile tentacles. This work, though executed some few years before that of Gaskell, forms a happy illustration of the broad results of the inquiry into the conductivity in the heart muscle, and will well repay perusal.

Some recent workers hold that it is an inherent property of the heart muscle to originate and conduct the stimulus which causes the heart to beat, they regarding this function as independent of the nervous ganglia and the nerve fibres in the heart. The author is not one of these. He says, referring to his work with Cash:—

"These experiments, which were not only very numerous but very varied, seemed to us to show that, just as in a medusa, there are in the heart two distinct channels, the nervous as well as the muscular, by which stimuli are conducted from one part of the heart to another, and that the nervous conduction may interfere with the muscular conduction" (pp. 32–4).

Furthermore, he points out that "the importance of the cardiac ganglia in originating the beats of the heart has been prominently brought forward since these lectures were given, by Dogiel and Archangelsky, *Pflüger's Archiv*, July, 1906" (p. 30); that "Kronecker and Imchanitzky have shown that the bundle of Stanley Kent and His (connecting the auricles and ventricles) can be ligatured without disturbing the coordination between the auricles and ventricles" (p. 225); and that Paukul has found nervous plexuses in that bundle, "injury of which disturbs coordination, while ligature of the muscular part of the bundle does not impair coordination" (p. 225).

In connection with this subject, the reader will also find further interesting matter in the appendices A and D. In appendix A the author treats on the conduction of stimuli and the contractility of organic tissues allied to that of the fibres of His and Purkinji in the heart—such as contractile vegetable protoplasm (producing the movements of plants), contractile animal protoplasm (amœba, leucocytes), neuro-muscular cells (fresh-water hydra). Appendix D is an epitome of an interesting contribution by the author's old friend and fellow-worker of nearly forty years ago in Ludwig's laboratory, Prof. Kronecker, of Berne, who has done so much to advance our knowledge

of the physiology of the heart. From it we gather, among other things, that it was Kronecker who discovered "that the heart is not irritable during systole"—denominated by Marey the refractory period; that Kronecker and his pupils found that the heart "ceases to beat if its contents are deprived of all stimulating properties"—from which fact we may infer "that there is no true automatism in the ventricle, but only intermittent action to a constant stimulus"; that "no other material enables the heart to beat except serum albumin, and to a very slight degree, serum globulin"; that Bowditch's law (minimal stimuli causing maximum pulsations, or in a word "all or nothing") holds good *without any exception*; that the rhythmicality of the flow through the arteries causes much more fluid to pass through them than when the flow is continuous; and that self-massage of the heart and vessels is an important factor in maintaining the efficiency of the circulatory mechanism. The last-named topic (self-massage of the heart, arteries, lymphatics, and veins) is also fully discussed by the author, who points out its important bearing on the nutritive integrity of the heart and the arterial wall. The author suspects that some may consider he has devoted too much space to the consideration of self-massage of the heart and vessels, and the conduction of stimuli in the heart. There is no doubt, however, that he is justified by the scant reference to these subjects in the text-books and by their practical importance.

In lectures ii. and iii., and in the appendix B, we have a very full and well-illustrated description of most of the instruments which have been devised for the measurement of blood-pressure in man for clinical purposes. The variety in construction shows us what a large amount of thought and ingenuity have been expended in devising them, so as to satisfy as much as possible clinical needs and accuracy. The introduction of such devices into clinical work has always been regarded with suspicion by physicians, who ever since the days of Herophylus have trusted with implicit faith to the infallibility of the tactus eruditus. In view of this natural distrust it is therefore of some importance, when discussing the claims of these innovations, to attach due weight to the objections which may be advanced to their adoption. The author does not, however, touch on this aspect of the clinical employment of blood-pressure apparatus. Probably this omission has arisen from want of space or the unsuitability of the subject for treatment in these lectures. We are therefore left to infer that he highly appreciates the advantages derived from the adoption of the methods now in use for the clinical measurement of blood-pressure, and that the practical value of these methods is amply justified by observation and experience; and there is no doubt that that is the verdict of the majority of those who have so far adopted these methods. The test of their usefulness is measured by the help and satisfaction they afford in the daily routine of practice rather than in the discovery of minor defects, which actually do not count for anything in disturbing the conclusions of the physician in clinical work. The author has, therefore, wisely devoted a large portion of his lecture to this important subject, which more than any other has made it possible to apply our knowledge of the physiology of the circulation to the service of man.

To comment on the remaining lectures in which the author discusses in an instructive manner various diseases of the heart and their treatment would unduly extend this review, and introduce topics somewhat extraneous to the scope of NATURE.

But these remarks should not be closed without a reference to the profusion of excellent illustrations, which add greatly to the clear conception of the text, and the admirable indices, which facilitate easy and accurate reference.

JUSTUS VON LIEBIG.

Justus von Liebig. By Jacob Volhard. Band I., pp. xii+456. Band II., pp. viii+437. (Leipzig: J. A. Barth, 1909.) Price 24 marks.

THIRTY-FIVE years have passed since Liebig died, and we are at length presented with a biography worthy of the man and his work. At the time of his death innumerable articles on his life and achievements appeared in the newspapers and periodical press of practically every country in the world, and almost every known scientific society having relations with chemistry made reference to his splendid services, and to the irreparable loss which humanity had suffered by his decease.

Some of these, such as the memorable lecture of Hofmann, are among the classics of chemical biography. But a generation has had to come and go before the appearance of a work which would serve to fix for all time without question Liebig's true place in the history of the science he did so much to illumine and develop. The delay has not been without its compensations. Time is required to estimate the real value of such services as Liebig was able to render. The outcome of his work was not wholly apparent during his lifetime, or even in the years immediately following his death. Germany was barely a united nation in 1873. Although the seed of her supremacy in chemistry, and in many branches of the chemical arts, had been sown in the early Giessen days, and although he lived to see the signs of its abundance, Liebig died before the harvest was garnered. It is hardly garnered yet. The impetus which he gave to the study of chemistry still makes itself felt, not only in his native country, but throughout the world. To him, more than to any other man, is due the inception of the movement resulting in that development and extension of the industries dependent upon organic chemistry which is one of the most remarkable features of our times.

Liebig, a man of good fortune in his life, as the Romans say, is fortunate also in his biographer. With the possible exception of Hofmann, no more fitting choice could have been made than Prof. Volhard. The author and his subject were on terms of strong personal friendship, dating, indeed, from Dr. Volhard's early youth. He was, in fact, like a son of the house in Liebig's family. For some years Dr. Volhard

acted as Liebig's assistant, and ultimately was entrusted by him with the delivery of the course of lectures on organic chemistry which he regularly gave in the summer semester. It is this intimate personal knowledge of his subject, and the whole-hearted sympathy, appreciation, and respect which a life-long intercourse had engendered, that gives to Dr. Volhard's work its special and peculiar value.

It is quite impossible within the compass of a notice such as this to do more than briefly indicate how admirably Dr. Volhard has risen to his opportunity. As already stated, the work is worthy of the subject, and no higher praise is possible.

Justus von Liebig—the first of his name to be ennobled—belonged to an Odenwald family which could trace its ancestry as far back as 1575. Some of the members spelled the name as it is pronounced, viz. Liebich. Justus was the second son in a family of ten children, and was born in 1803. His father, Johann Georg Liebig, was a druggist and drysalter in Darmstadt, who had his shop in a little house in the Kaptaneigasse, one of the oldest streets in the old town. His mother, Marie Caroline Moser, was described as an active little woman with the bright eyes and sharply cut features of her famous son. Indeed, from her Liebig seems to have inherited also many of his mental and intellectual characteristics, his energy, and remarkable power of work.

It is easy to determine the conditions which made Liebig a chemist. From his earliest years he was familiar with the sight of chemical operations. Chemical utensils and apparatus were his toys, and for a time he had no other aim in life than to follow his father's occupation. But as his knowledge increased his interests widened, and science eventually claimed him. Even before he left the gymnasium he had settled in his own mind what his life's work was to be—"Chemiker will ich werden, nicht Apotheker"—and accordingly in 1820 he was sent to Bonn to listen to Kastner's dull and formal prelections. In the following year he went with Kastner to Erlangen, where he published his first scientific communication. It appears in Buchner's *Repertorium der Pharmacie*, xii., 412, with a commendatory notice from Kastner, under the title "Einige Bermerkungen über die Bereitung und Zusammensetzung des Brugnatellischen und Howardschen Knallsilbers. Vom Herrn Liebig, der Chemie Beflissenen aus Darmstadt." With August von Platen as his friend, Liebig was "ein ganzfideler Student," to whom the Erlangen "Karzer" was not altogether unknown, as the acts of the university testify. Kastner was not very inspiring, and knew nothing of analysis.

From Erlangen Liebig passed to Paris, where, thanks to the interest of Humboldt, he was well received by Gay-Lussac, Thenard, Dulong, Biot, and the rest of the remarkable group which made Paris the chief centre of scientific activity of that age. A new era dawned on Liebig; with Gay-Lussac his relations became especially cordial. They worked together on fulminic acid, and under Gay-Lussac's inspiration and direction Liebig became an investigator. "Liebig," says his biographer, "bewahrte dem väterlichen Freund die wärmste Verehrung. Sein Zusammenarbeiten mit Gay-Lussac bildet den Glanzpunkt seiner Jugend." To the end of his days Liebig always spoke of this association with the warmest feelings of pleasure and gratitude. He was wont to relate how, when some particularly difficult analysis had succeeded, or when some new and surprising fact had been elicited, the two investigators sought to relieve their excitement by waltzing together round the laboratory table.

It was mainly through the good offices of Gay-Lussac, working through his friend and fellow academician Alexander von Humboldt, that the Grand Duke of Hesse was led to interest himself still further in the fortunes of the young man "der Chemie Beflissenen aus Darmstadt," and in 1824 Liebig, in the twenty-first year of his age, was appointed, without previous consultation with the faculty, and somewhat to their displeasure, extraordinary professor of philosophy at the University of Giessen. On the death of Zimmermann in the following year he became ordinary professor and sole teacher of his subject. Liebig's life during the twenty-eight years he remained at Giessen is, of course, the main theme of Dr. Volhard's book. The principal features of his Giessen career are familiar to everyone who has even the slightest acquaintance with the development of chemistry during the second quarter of the nineteenth century, but these features are now filled in by Dr. Volhard with a degree of detail which is almost Boswellian in its completeness and exactitude. One rises, in fact, from the perusal of the narrative with the conviction that surely the last word on the subject has been said. Liebig's chief work was, of course, done at Giessen, and the twenty years of his subsequent life at Munich, whilst it in nowise diminished, hardly added to the world-wide and imperishable reputation which his sojourn at the "little university on the banks of the Lahn" had secured for him.

Liebig's life was so full, his services were so remarkable, and his achievements so striking, that not even the most unskilful of biographers could fail to invest his story with interest.

Dr. Volhard is very far from being an unskilful biographer, and he has put together his great mass of material with circumspection and judgment. Much of Liebig's correspondence has already been published, and his relations to his contemporaries and to the scientific movements of his time are already well known, and passing references to these matters, sufficient to make the story complete, were alone necessary.

Exception might perhaps be taken to certain features in the construction and plan of the work, and, as a book for general readers, it suffers from the common fault of biographies of being over-elaborate. But Dr. Volhard may urge that his book was primarily intended for those who have a lively and abiding interest in Liebig, viz. the chemists who revere his name and who seek to be inspired by his example, and these will certainly not cavil at the wealth of detail which is manifested in this monumental work.

T. E. THORPE.

THE CONSTRUCTION OF SHIPS.

The Design and Construction of Ships. By Prof. J. H. Biles. Vol. i. Calculations and Strength. Pp. viii+423; 280 illustrations. (London: C. Griffin and Co., Ltd., 1908.) Price 25*s.* net.

THIS is the first of two volumes dealing with modern methods of procedure used in connection with the design and construction of ships. It embodies details of courses of instruction given to students of naval architecture during the seventeen years the author has occupied the chair of naval architecture in the University of Glasgow. That professorship was founded about twenty-five years ago by the generosity of Mrs. John Elder, widow of a celebrated marine engineer, and was the first attempt made in any British university to provide instruction in the science and practice of shipbuilding. The Admiralty had previously established schools of naval architecture, mainly for the purpose of training their own shipbuilding officers, and it is noteworthy that all the men who have held the Glasgow professorship, the late Dr. Elgar, Mr. Jenkins, and Prof. Biles, were originally trained for the Admiralty service, but quitted it for appointments in private establishments. All of them had attained eminence in the practice of their profession before becoming teachers; they continued their practice in the design and construction of ships during the period of their professorships. Students at Glasgow consequently have had the good fortune to be taught by men who themselves received a thorough scientific training at the outset of their careers, had maintained close touch with current practice, and were familiar with the latest advances and improvements in shipbuilding and marine engineering. That fact is apparent throughout the volume under review, and adds much to its value.

The book is described in the preface as primarily intended for young students, and this intention has been admirably fulfilled. The author also ventures to hope that "many who have been students and some who in their daily work are interested in the problems dealt with may find some assistance" from the perusal of its pages. This hope will undoubtedly be realised. The arrangement of the book is excellent, its style concise and clear. Detailed explanations are given of processes of calculation and methods of procedure, in a form which should suffice for the guidance of those desirous of making work of that nature the principal occupation of their lives. Many of the sections—including those containing illustrations of types of ships, details of tonnage laws, rules for freeboard, and other subjects—should prove of interest to all persons connected with shipping. The plates, diagrams, and other illustrations are numerous, and the book as a whole is well produced. The volume has its own index.

The author does not lay claim to much originality, although not a little original work done by himself has been embodied. The book is valuable also for its tabulated data, much of which is drawn from professional work done by the author, or placed at his disposal by other authorities.

Growing as it has done out of courses of instruction given to students at Glasgow, the book has naturally taken a form which adapts it for use as a textbook for students generally. Consequently it should greatly assist teachers as well as students of naval architecture, and particularly those in Great Britain and the United States. For a long time there has been a need for such a book; and in saying so, no discredit is cast upon smaller and less expensive textbooks previously produced, largely with a view to use by less advanced students than those who follow complete university courses in naval architecture.

This volume is subdivided into three sections. In the first, methods of calculating areas, volumes, and positions of centres of gravity are dealt with. A full account is given of applications of descriptive geometry to the delineation of the forms of ships and of various parts of ship-structures. Descriptions of various types of ships employed for war and commerce are also given, and abundantly illustrated. The information is elaborate and up to date, as is indicated by the fact that it includes drawings of the *Dreadnought* and *Invincible* classes in the Royal Navy; particulars of the latest ocean-going destroyers and submarines; descriptions of many types of cargo and passenger steamers; and details of steam and sailing yachts.

The second section of the volume is devoted to ship calculations, and its scheme is comprehensive. It includes details of numerical methods, as well as interesting descriptions of mechanical integrators and integraphs which have been devised in recent years for measuring areas, moments, and moments of inertia of plane curves. Naval architects have been largely assisted by these instruments, and the drudgery of numerical calculation has been greatly reduced. All classes of engineers, as well as many scientific men, will be interested in the descriptions given of the applications of these mechanical integrators to calculations for the displacements, positions of centres of buoyancy and metacentres of ships, and work connected with determining the conditions of stability.

The important subject of the strength of ships is one with which Prof. Biles has been much concerned, and it is treated exhaustively in the third section of the book. Investigations and experiments of a special character were carried out by a committee (of which he was a member) appointed by the Admiralty about six years ago after the loss of the torpedo-boat-destroyer *Cobra* in the North Sea. Prof. Biles and his assistants and students at Glasgow undertook a great mass of calculations for representative vessels on behalf of that committee, and also analysed the results of experiments made on a typical torpedo-boat-destroyer in order to determine her behaviour when subjected to exceptional longitudinal bending moments which produced sensible changes of form. Much of the information in regard to these experiments had been published by Prof. Biles in the Transactions of the Institution of Naval Architects, but it is brought together in the volume under review in a form which will be useful for reference, and which adds to the

interest of his general treatment of the strength of ships.

The book will be heartily welcomed by all connected with the design and construction of ships; the appearance of the second volume will be awaited with interest. W. H. WHITE.

HEREDITY AND EDUCATION.

Education and the Heredity Spectre. By Dr. F. H. Hayward. Pp. xv+147. (London: Watts and Co., 1908.) Price 1s. net.

WHAT Mr. Bernard Shaw means when he says that "the bubble of heredity has been pricked" is that the theory that the moral characters acquired by an individual during his lifetime are transmitted to his descendants has been exploded. We are all, including the author of the book before us, pretty well agreed that this is so. It is not supported by the scanty evidence on this point which the biologist has collected. Nor need we grieve that it has gone. For, if it can be maintained that a belief in it was an incentive to virtue, it is equally certain that such a belief was an excuse for vice, as was clearly seen by a little girl who, when told by her nurse that if she was naughty her grandchildren would be naughty too, pointed out that, if that was true, the reason that she was naughty was that her grandmother had been.

The conclusion reached by Mr. Shaw as to the bearing of the pricking of the bubble on education is that "the vilest abortionist is he who attempts to mould a child's character." That reached by Mr. Hayward is the diametric opposite of this. He is a Herbartian. Herbart asked:—

"Does a human being bring with him into the world his future shape, or does he not? In respect to his body he doubtless does; but that is not our question. We speak of the mind, the character, the entire disposition."

And Herbart's and Mr. Hayward's answer is that he does not; and that, that being so, it is not merely legitimate, but desirable, to attempt to mould a child's character.

But before we proceed further we must make sure that we keep two questions, which are probably puzzling our mind at the same time, perfectly distinct. One is a question for the biologist, the other for the educationist. The one is, "Can a child's character be moulded?" the other, "Is it desirable to do it deliberately?" With regard to the former question, the answer given by Dr. Archdall Reid, who has devoted much thought to this point, is "Yes." According to Dr. Reid, all the attributes which distinguish a civilised man from a barbarian (the two terms are relative, of course) have been acquired by the former during his lifetime. If this is true, an English boy brought up from birth in a Zulu kraal will, when a man, have the morals and ideals of a Zulu. He will only differ from the other inhabitants of the kraal in having a paler skin and the other physical characters which distinguish the two races. Such experiments may have been made, but it is highly unlikely that they have been accurately recorded. The presence of anyone capable of doing so would spoil the conditions of the experiment. But even if this view of the nature of our morality is correct, it does not follow that it is desirable to attempt to mould a child's character. It rather shows that we cannot help moulding it by everything that we do, and that any little deliberate attempts that we make will count for so little in comparison with what we have already done, and will go on doing, that they will not make much difference.

From the educational side the book is well worth reading, and the subject discussed is of first-rate importance; but our author is not a biologist either by sympathy or achievement. Was it worth while to poke fun at Mendel for his researches on green peas (p. 134)? People lay so much too much stress on the material that is dealt with in an investigation. Personally, we set more value on a man who discovers, not *everything*, as some Mendelians hold, but, say, "a rough quarter" by experiments "with green peas," than on one who discovers practically nothing by an excursus on man. We quote the whole passage:—

"(3) *Mendelism.*

"The question of heredity has entered on a new phase during the past ten years, owing to the unearthing of Mendel's researches on green peas. The plant again! We are to discover the laws of human nature by the study of heredity in non-conscious, non-moral plants."

Does Mr. Hayward really think that we investigate natural processes for the benefit of those who apply the information which we give them? The reason that Mr. Hayward dislikes the plant so is that, according to him, the non-Herbartian doctrine of education is based on what he calls the "plant" metaphor.

"The future form of a plant is admittedly determined in advance. True, there are 'variations' and 'mutations,' the laws of which we are likely, sooner or later, to know; true, also, *even plants*[1] are plastic in a measure, to environmental influences. Broadly, however, we may say that the fate of a plant is fixed by the nature of the germ from which it springs."

We quote this to show that Mr. Hayward's biology is shaky. For it is now generally recognised that one fundamental difference between animals and plants is the much greater susceptibility of the latter to environmental changes.

RECENT STUDIES IN ATMOSPHERIC ELECTRICITY.

Die Luftelektrizität. Methoden und Resultate der neueren Forschung. By Prof. Albert Gockel. Pp. vi+206. (Leipzig: S. Hirzel, 1908.) Price 6 marks.

OF late years there has been great activity in this country in investigating electrical phenomena in gases and in advancing and discussing theories as to the nature and properties of ions. But this work has been mainly done in the laboratory or by mathematicians. In central Europe, thanks largely to the influence of Exner and of Elster and Geitel, there have been many workers studying the electrical phenomena presented by nature. Amongst them Prof. Gockel takes a distinguished place. In the present volume he gives an exceedingly up-to-date account of our knowledge of atmospheric electricity. The amount that has recently been written on the subject will

[1] The italics are ours.

impress itself on anyone who refers to the *Physikalische Zeitschrift* or the publications of the Vienna Academy. The references in the present volume are evidence of Prof. Gockel's familiarity, not merely with recent work in German, but also with that in English, whether done here or in America. He makes, for instance, numerous references to Simpson's observations in Lapland.

The book consists of a three-page introduction, five chapters, and a short conclusion, and has a table of contents. Chapter i., pp. 4 to 61, deals with the electrical conductivity of the atmosphere. After describing Elster and Geitel's dispersion apparatus, and the instruments of Ebert and of Gerdien for measuring ionic charges and conductivity, it gives an account of the results obtained with these instruments by different observers in different places, and deals with the questions of diurnal variation and the influence of various meteorological conditions. Chapter ii., pp. 62 to 120, deals mainly with the potential gradient and its determination by means of water-droppers, flame and radium collectors. This includes the results obtained —especially in recent years—at the ground and those derived from balloon ascents. The diurnal and annual variations in the potential gradient, the relationships of potential gradient and ionisation, and the influence of meteorological conditions are amongst the subjects discussed. Chapter iii., pp. 120 to 149, describes the measurements by Gerdien and others of the vertical current in the atmosphere, deals with the charges brought down by rain and snow, and includes two or three pages on aurora. As evidence of its up-to-date character, it may be mentioned that it describes Mr. C. T. R. Wilson's apparatus for measuring the earth-air current. Chapter iv. is devoted to earth-currents. Its length, only 9½ pages, forbids much detail, but there is an account of several of the more important observations, including those by Weinstein in Germany. Chapter v., pp. 159 to 202, deals with the sources of ionisation in the atmosphere. It discusses the radio-activity of air from the ground, and of rain, and the radio-active emanation in springs, the observations made by Elster and Geitel and others with negatively charged wires, and refers to recent work by Gerdien, Rutherford, Strutt, Campbell, Dike, Eve, and others. A few pages at the end relate to various theories.

In a book of such modest dimensions it is inevitable that some parts of the subject should not be very fully discussed, but it is unquestionably a work which every serious student of atmospheric electricity should possess and study. Very few points call for criticism. There are, however, two historical references which seem to overlook the work of British investigators. Mascart is referred to on p. 80 as the first to introduce photographic registration of potential difference, but in reality the Kelvin water-dropper at Kew has recorded photographically since 1861. Again, the discovery of the resemblance between the diurnal variations of potential gradient and barometric pressure is said on p. 114 to have been made by Hann in 1889. Prof. J. D. Everett, however, detected it in 1867 (*Phil. Trans.*, vol. clviii., p. 358, and plate xxi.).

C. CHREE.

OUR BOOK SHELF.

The Ethical Aspects of Evolution, regarded as the Parallel Growth of Opposite Tendencies. By W. Benett. Pp. 220. (Oxford: The Clarendon Press, 1908.) Price 6*s.* net.

THIS book is full of original opinions vigorously and uncompromisingly expressed. As the title indicates, the author's main thesis is that the process of evolution does not mean the progressive elimination of evil and pain, or a progressively increasing surplus of good and pleasure. He adduces biological evidence to show that the organism which has attained the finest adjustment to its environment is the organism which can be most easily thrown out of adjustment, and the one to which misadjustment, when it comes, is most disastrous. So history teaches us that if civilisation has meant higher forms of virtue, it has also meant lower depths of vice; and that as our knowledge increases so does the consciousness of ignorance.

From this point of view, Mr. Benett makes an effective destructive criticism on all optimistic evolutionary theories of ethics which have as central principle the possibility of perfect adjustment and the extrusion of all inharmonious factors from experience. He then proceeds to put forward his own theory. Failing the criterion of a net surplus result of progress in good or pleasure, Mr. Benett holds that our system of valuations must rest on the conception of progress itself. A teleological basis, he admits, would be more adequate. But we are unable to find any finite end which will give unity to the divergent tendencies of human nature; and the transcendental end, though we are compelled to posit it, is for ever beyond our ken. The essential characteristic of progress is, for Mr. Benett, increase of force; it is this which in the last possible analysis commands man's esteem and admiration, and affords a criterion of good and evil.

There is here an attempt to unite a scientific neutrality with a positive ethical construction. Progress is no increase in the net value of life; it means the impartial development of good and evil; yet progress must be our criterion of value and good. One need only point to Mr. Benett's criticism of hedonism, where he points out that just because pleasure is an impartial stimulant of all sorts of action it cannot be the criterion of good, to show the inconsistency of this position. To avoid the difficulty by making progress represent only the positive aspect of evolution is to fall on the other horn of the perpetual dilemma of ethical construction, and make good the criterion of good. Apart from this defect of fundamental theory, Mr. Benett's book shows considerable power of psychological analysis; his treatment in the later chapters of complex moral facts and concrete virtues is often admirable. His argument is always forceful, his style is powerful, and one feels throughout the presence of a straightforward insistence that we must face the facts as we find them of human nature and the world. These are qualities which go far towards a valuable re-handling of moral problems.

The Poisonous Terrestrial Snakes of our British Indian Dominions and how to recognise Them. By Major F. Wall. Second edition. Pp. x+69; illustrated. (Bombay: Natural History Society, 1908.) Price 2 rupees.

To those whose travels have never extended beyond western Europe it is a difficult matter to realise how largely poisonous snakes loom in the life of our native fellow-subjects in India, or to appreciate the heavy annual list of casualties due to snake-bite. To mitigate the evil, the European and the native medical staff of the country are now bringing into play the latest remedies of their science, but they are frequently

hampered in their endeavours by the difficulty of identifying the particular kind of noxious serpent with which they may be called upon to deal. It is largely with the view of supplying a ready method of making such identifications that the unpretentious work before us has been presented to the public. That it has been heartily appreciated is made evident by the fact of its having reached a second edition, after the sale of a first issue of 2500 copies. The author relies on the arrangement, size, and number of the scales as affording the easiest clue to the identification of species, and for this purpose gives figures of the scaling of certain parts of the body or head of a considerable number of the thirty-nine species recognised which in his opinion render identification easy and certain.

In the present edition the author has ventured to recognise more species than are admitted in Mr. Boulenger's volume in the "Fauna of British India." He is of opinion, for instance, that under the name of *Ancistrodon hypnale*, two species—one from Ceylon and the other from the Western Ghats—have been confounded, while a new krait is recognised from Assam, and the *Bungarus candidus of* Boulenger is split up into several species. In addition, *Pseudocerastes persicus* has recently been identified in British India. Apart from the special purpose in connection with snake-bite, the book is a useful and handy guide to the Indian "Thanatophidia." R. L.

Gray's New Manual of Botany. Re-arranged and extensively revised by B. L. Robinson and M. L. Fernald. Seventh edition. Pp. 926. (New York: American Book Company, n.d.)

THIS well-known flora of the central and north-eastern parts of the United States of America was originally compiled in 1848 by Dr. Asa Gray, who was professor of natural history in Harvard University. It has passed through six editions, and has been revised three times, the last revision having been undertaken by Dr. S. Watson and Prof. J. M. Coulter in 1890. Another edition had become desirable if only to bring the book into conformity with the pronouncements of the International Botanical Congress at Vienna, and no more opportune occasion was likely to arise for carrying out at the same time the practically inevitable displacement of the arrangement of Bentham and Hooker's "Genera Plantarum" by the more modern system elaborated by Dr. Engler. These sweeping reforms have been effected by the new editors, who are botanical professors at Harvard University, and therefore officially entitled to prepare the flora, of which the copyright is held by the university.

The authors have also modified the geographical limits covered by the manual, whereby certain territories in the west are excluded, and considerable areas in Quebec, Ontario, and other Canadian provinces are included. The changes do not by any means end here; practically the arrangement of every important *family*—to use the word officially recommended for the group, better known as an *order*—and every large genus has been re-cast, so that the title of the book has been advisedly qualified. The assistance of specialists has been obtained for the descriptions of the grasses, orchids, Cratægus, and a few other genera.

The flora is confined to Pteridophyta and Spermatophyta; there is a considerable increase in the total number of species, that now exceeds four thousand. Under the genus Panicum, seventy-three species are distinguished, and under Carex as many as a hundred and eighty-five. The forms of Cratægus, a species that is highly variable in America, are brought under sixty-five species by Mr. W. W. Eggleston.

Undoubtedly the revision will be cordially welcomed by botanists, and should prove especially useful to botanical workers in south-eastern Canada. The admirable series of analytical keys that were a feature of the older editions have been maintained, and further help is given for difficult genera in the shape of small illustrations, by the side of the text, of those parts of the plant that furnish diagnostic characters.

The New Word. By Allen Upward. New edition. Pp. 317. (London: A. C. Fifield, 1908.) Price 5*s.* net.

Scientific Corroborations of Theosophy: a Vindication of the Secret Doctrine by the Latest Discoveries. By Dr. A. Marques. Revised and greatly enlarged edition. Pp. iv+152. (London: The Theosophical Publishing Society, 1908.) Price 2*s.* 6*d.* net.

MR. ALLEN UPWARD describes his book as "a plea for reason against authority," and proceeds to discuss a number of problems of modern science from a layman's point of view. Men of science will approve the spirit in which Mr. Upward writes, even if they remain unconvinced by his arguments.

Readers will discern from the title to his book the line of thought which characterises the volume of Dr. Marques.

LETTERS TO THE EDITOR.

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

The Boiling Point of the Radium Emanation.

IT was shown by Rutherford and Soddy in 1903 that the radium emanation was condensed from the gases with which it was mixed at a temperature of about −150° C. From observations of the range of temperature of condensation and volatilisation it was concluded that the condensed emanation exerted a sensible vapour pressure. This has been confirmed by later experiments, using much larger quantities of emanation. Sir William Ramsay and Cameron have pointed out that the emanation, condensed in a glass tube kept at the temperature of liquid air, can be removed by continuous pumping, thus indicating appreciable vapour pressure even at that low temperature. I have found that the rate of removal of the emanation in this way increases rapidly as the temperature of complete volatilisation is approached.

In the initial experiments of Rutherford and Soddy only very small quantities of radium were available, and the partial pressure of the emanation in the experiments was exceedingly small. If the emanation behaves like an ordinary gas, it is to be expected that the boiling point of pure emanation at atmospheric pressure should be much higher. I have recently made experiments to test this point. As the volume of pure emanation available in the present experiments was only about 1/20 cubic millimetre it was necessary to employ special methods to investigate the boiling point of the emanation at various pressures. Purified emanation corresponding to the equilibrium amount from about 100 milligrams of radium was compressed into a fine glass capillary of about 1/20 millimetre diameter. The end of the capillary dipped into a pentane bath, which was cooled down to any desired temperature, measured by means of a thermocouple. The point of initial condensation was marked by the appearance of a brilliant point of phosphorescent light, due to condensed emanation, at the coldest part of the capillary. In this way I have found that the temperature of initial condensation of the emanation rises from about −150° C. at a very low pressure to about −65° C. at atmospheric pressure. This fixes the boiling point of the emanation at atmospheric pressure at about −65° C., or 208° absolute.

As it is a difficult matter to purify completely the small volume of emanation and to keep it pure, the observed pressure of the emanation and mixed gases at the temperature of condensation was corrected for by taking the true volume of the emanation from 1 gram of radium in equilibrium as 0·585 cubic milligram. This calculated volume is in excellent agreement with the minimum value which I have found experimentally. As the emanation is apparently an inert gas of atomic weight 222, it is of interest to compare its boiling point with those of the heavier inert gases found in the atmosphere. The boiling points of argon, krypton, xenon, and emanation are, respectively, 86·9, 121·3, 163·9, and 208 degrees absolute. It will be noted that as the boiling point of krypton is about intermediate between that of argon and xenon, so the boiling point of xenon is nearly the mean between that of krypton and emanation.

If the capillary tube containing pure emanation is quickly placed in the pentane bath, cooled well below the temperature of initial condensation, under a microscope small drops of liquid emanation are seen on the walls of the capillary. The position of each globule is marked by a brilliant local phosphorescence of the glass of the capillary.

E. RUTHERFORD.

University, Manchester, February 13.

Crocodiles and Tsetse-flies.

MY attention has been directed to a paper read before the Royal Society of Arts by Mr. James Cantlie on January 27 called "The Part played by Vermin in the Spread of Disease," published in the society's journal (January 29, pp. 202–4). Mr. Cantlie is there reported to have said:—"In sleeping sickness the disease is transmitted by the tsetse-fly, and the crocodile is believed to be the alternative host, the fly serving as a carrier only" (p. 204).

I do not know upon what evidence or upon whose observations Mr. Cantlie based his statement concerning the crocodile, but to judge from many similar statements that have appeared from time to time recently in the Press, the idea seems to be generally prevalent that Prof. Koch either observed or believed that the crocodile was a "reservoir" host for the human trypanosome (*Trypanosoma gambiense*), just as big game is for the trypanosome causing the "nagana" disease of animals (*T. brucei*). Prof. Koch, however, has never expressed such a view in his published papers. In his last work on this subject, "Über meine Schlafkrankheits-Expedition" (Berlin: Dietrich Reimer, 1908), he wrote:—"Dem ersten . . . Krokodil entnahmen wir sofort frisches Blut, um Präparate zu machen und Kulturen anzulegen, und wir hatten in diesem Falle auch insofern Glück, als die Kulturen gelangen, wodurch wichtige wissenschaftliche Resultate erhalten wurden. Namentlich konnte auch festgestellt werden, dass das Blut des Krokodiles zwar Trypanosomen, *aber nicht diejenigen der Schlafkrankheit enthält*" (the italics are mine).

All that Prof. Koch showed was that the crocodile in the Victoria Nyanza is infected by a species of trypanosome, and that tsetse-flies (*Glossina palpalis*) feed on the blood of the crocodile. Both these facts had already been made known by English observers. The bare fact that the crocodile may be infected by trypanosomes is no evidence for connecting this reptile with sleeping sickness. The perch, bream, tench, and other fishes in the Norfolk Broads also commonly harbour trypanosomes in their blood, but are not to be regarded as a danger to mankind on that account. There is, in fact, no evidence whatever that the crocodile serves as an "alternative host" of the human trypanosome. It is inherently improbable that any reptile should play such a part.

I hold no brief for the crocodile, and should hear of its extirpation in the Victoria Nyanza without the least regret; I only desire that our scientific knowledge of the sleeping-sickness trypanosome should be correctly stated. It is possible, and indeed for many reasons probable, that a "reservoir" host for *T. gambiense* exists, but none has been discovered as yet. Only the human species has been found so far to be naturally infected with the trypanosome of sleeping sickness, although many other *mammals* can be inoculated with it as a laboratory experiment.

Rovigno, February 10. E. A. MINCHIN.

The Production of Prolonged Apnœa in Man.

IT is a matter of common knowledge that the time for which the breath can be held is increased by a preliminary bout of deep breathing, and divers often make use of this fact to increase the time for which they can remain under water. So far as I am aware, it is not usual to perform this forcible respiration for more than a short period, the pearl-divers of Ceylon, for instance, taking only a few deep breaths before descending; but in order to get the maximum effect a prolonged period is necessary. In my own case I found that whilst with no preliminary forced breathing I could hold my breath for only forty-two seconds, I could hold it for 2m. 21s. after one minute's forced breathing, for 3m. 21s. after three minutes' breathing, and for 4m. 5s. after six minutes' breathing (*c.f. Journ. Physiol.*, vol. xxxviii.). The effect of the forced breathing is to wash out such considerable quantities of carbon dioxide from the blood and body tissues that even at the end of the three or four minutes' apnœa they contain less of the gas than when the breath is held for forty-two seconds without any preliminary forced breathing.

In theory, therefore, the deeper, more rapid, and more prolonged the forced respiration the greater its efficacy; but it is not so in practice. With some people the sensations produced by even a minute or two of forced breathing are very unpleasant. The hands and feet tingle and become numb, a dizziness is felt, and there is a strong disinclination to continue the breathing (*cf.* Haldane and Poulton, *Journ. Physiol.*, vol. xxxvii.). In my own case a period of eight minutes' breathing caused the muscles of the hands to pass into a condition of tonic rigidity, and they remained completely paralysed for the first 1½ minutes of the subsequent apnœa. Doubtless the unpleasant sensations are diminished by practice, but it is probable that for ordinary purposes it would be best not to continue the forced breathing for more than two or three minutes. Also there is a distinct element of risk if a diver remains under water almost to his limit after forced respiration. The amount of oxygen left in the lungs and blood then becomes so low that there is danger of fainting. Haldane and Poulton quote a case, of which they were informed by Dr. Collier, in which a diver lost consciousness when at the bottom of a swimming-bath after he had employed forced breathing to prolong his stay under water. Fortunately, he was rescued before death occurred, but undoubtedly the chance of fatality is increased by a preliminary forced respiration.

In the absence of forced breathing, the accumulation of carbon dioxide in the blood when the breath is held affords a natural safeguard, for it stimulates the respiratory centre to action with ever-increasing force, and ultimately compels respiration before the oxygen in the system has sunk to danger-level. However, the risk due to oxygen deficiency can be readily overcome. Hill and Flack have shown (*Journ. Physiol.*, vol. xxxvii.) that if a few breaths of oxygen are taken during quiet breathing, the time for which the breath can be held is generally more than doubled. Not only is the oxygen want of the system thereby eliminated, but, in addition, the oxygen renders the respiratory centre considerably less sensitive to carbon dioxide, and so permits it to accumulate to a greater extent than usual in the body. The same thing holds after forced breathing, and I found that if one to four breaths of oxygen were taken at the end of the forced respiration, the breath could be held about twice as long as in absence of oxygen. After one minute's forced breathing I held my breath for 4m. 18s.; after three minutes' breathing for 6m. 34s., and after six minutes' breathing for no less than 8m. 13s.

So far as I can ascertain, the world's record for a professional diver remaining under water in a tank was made by Miss E. Wallenda in 1898, when she reached 4m. 45⅘s.

I do not know in what way divers prepare themselves for such feats, but presumably it is by a preliminary forced breathing only, without oxygen inhalation. Hence this record is probably comparable with my record of 4m. 5s., and in that case it follows that forced breathing, together with oxygen inhalation, might enable some individuals to stay under water for nine or ten minutes. Moreover, they could achieve such times without any risk of loss of consciousness. Even at the end of my eight minutes' record the air in my lungs still contained 46 per cent. of oxygen, or three times the normal amount.

The practical applications of this method of forced breathing and oxygen inhalation are obvious. Prof. Herdman states (Report of Ceylon Pearl Oyster Fisheries, part i., p. 63; part ii., p. 13) that the maximum time the best pearl-divers (the Arabs) remain under water is, in his experience, only ninety seconds, whilst the Tamil and other divers vary from thirty-five to fifty seconds. Of course, one would not for a moment expect them to attain the times above mentioned, as they are performing violent muscular work whereby the rate of production of carbon dioxide by the body is greatly increased. Still, there is little doubt that if they performed about two minutes' forced breathing, and took a single deep breath of oxygen at the end of it, they could, without risk, double or treble their average time under water. This might be of especial value to them when fishing in the deeper waters. Prof. Herdman says that while the usual limit of the divers is about nine fathoms, exceptional divers could go to fifteen fathoms, "but they had barely time to secure a single handful of the bottom before having to come up in an exhausted condition." The method might also be of value to sponge-divers, and to some extent also for rescue work in mines and drains poisoned by foul air, when proper rescue apparatus was not available.

22 Norham Road, Oxford. H. M. VERNON.

The Isothermal Layer of the Atmosphere.

THE difference of opinion between Mr. Hughes and myself apparently comes to this; he considers (February 11, p. 429) that radiation plays an important part in the temperature that is recorded by meteorographs sent up with a balloon, and I think that, save in exceptional circumstances, radiation may be neglected. We are agreed in stating that the temperature of the metal strip can only be altered by contact with the air and by radiation, and the only question is the relative values of these two causes. Furthermore, I gather that Mr. Hughes thinks that whether the ascent be by night or day, after a certain height the temperature is unduly raised by radiation from what he calls the hot planet.

Now, first, the thermograph is made of polished metal, and is protected by a polished metal case, and it is well known that a polished metal surface is not susceptible to radiation. One need only mention the double vacuum bottle in which liquid air is kept, the commercial "thermos flask." Loss or gain of heat by radiation is practically excluded by silvering the internal surfaces.

Secondly, it must surely be admitted that radiation must be very different by night from what it is by day. It is true that the sun subtends but a small solid angle, and the earth an angle of nearly 2π, but the power of radiation varies as the fourth power of the absolute temperature. In saying that all radiation was insignificant compared with that of the sun, I was thinking of ordinary experience. In the tropics a man protects himself against the sun; to quote a very ancient writing, "there is nothing hid from the heat thereof." There are places in the high valleys of Switzerland where in calm, sunny weather a person may sit out of doors in the sun in perfect comfort, although the country round is deeply covered with snow and the temperature is far below the freezing point. On the other hand, in the Arctic and Antarctic winter it is protection from the wind that is sought; all accounts agree that if there be no wind extremely low temperatures are not unpleasant, and loss of heat by radiation is not feared.

But Mr. Hughes admits that radiation is stronger by day, and says that if it is not apparent on the trace it must be because the traces differ so much *inter se*. This is a question of fact, and I can only refer him to the published records and to my previous statement that traces made in the day do not differ from those made at night. There is a striking similarity about the general form of all the traces, excepting those obtained in the daytime from a balloon which did not burst.

With regard to the vertical speed, we know that the time occupied in falling is about half that occupied in rising, because we have been able to ascertain by observations with a theodolite that the horizontal distance passed over during the fall is about half that passed over during the rise. We do not now use any parachute, and we used not to use one of more than 1 sq. foot area. The cross-section of the balloon before bursting is probably 25 sq. feet to 30 sq. feet. Inasmuch as at 20 km. height the air density is only one-sixteenth that at the ground-level, the initial rate of fall will be four times the final rate, and must therefore be greatly in excess of the rate of ascent. Notwithstanding this, the temperatures recorded are to all intents and purposes identical. Differences exceeding 3° C. between the up and down trace at the same height are very rare; 6° C. is the maximum recorded, and anything more than 4° is only produced by change of level of an inversion surface in the lower strata occurring during the ascent. W. H. DINES.

Barometric Oscillation.

IN NATURE of December 3, 1908 (p. 130), Mr. Dines, in reference to a previous note upon the semi-diurnal barometric oscillation, gave as his opinion that the semi-diurnal temperature oscillation is the result of pressure variation.

In connection with this question, it seems to me of some value to give here a couple of results derived from the Batavia observations. They are related to pressure oscillations of extra-terrestrial origin, like the semi-diurnal variation, and show a pressure change followed by a change of temperature.

At Batavia the well-known barometric oscillation with a period of 3½ years is very definite. It is followed by an equally distinct temperature oscillation of the same period. The difference in time is 6½ months. The temperature, moreover, shows the remarkable fact that the seven-yearly means from 1871–1905 are increasing regularly from 0°·08 C. to 0°·10 C. every seven years, so the temperature of the air increases by about 0°·01 a year.

In the second place may be mentioned the influence of the 26-day period of the sun's rotation on meteorological data. A corresponding pressure oscillation is clearly shown. It is followed after nine days by a variation, of the same kind, of the temperature and the daily range of pressure.

There seems to be a close connection between the above-mentioned pressure oscillations and the influence of the sun's prominences on the earth. Both coincide in relation to time. C. BRAAK.

Observatory, Batavia, January 11.

Electrons and Atomic Weights.

LOTHAR MEYER suggested that the slight divergences between the theoretical and actual atomic weights in the periodic system might be due to the imprisonment of a quantity of the æther within matter; Lord Kelvin ascribed to the æther a weight of one-thousand billionth of a gram per cubic meter. Meyer's suggestion is hardly acceptable.

In the light of present-day theories of the perpetual disintegration of matter, it seems more likely that the atomic weights vary through loss of electrons; when the loss has reached a certain critical point a re-adjustment may take place, resulting in transmutation to a lower element.

If there be any truth in this theory, it may be supposed that the atomic weights of the elements may vary in different worlds of space, the more or less uniform weights found on the earth being due to the fact that the period of formation was identical in all cases. In this connection, it would be interesting to determine the atomic weights of the elements in meteorites, an investigation which I am unable to undertake at this time, but which I hereby suggest. ALFRED SANG.

96 Boulevard de Versailles, St. Cloud, S. et O., January 12.

FURTHER ANTARCTIC RESULTS.[1]

THE Belgian Antarctic Expedition has issued another seven sections of the ten important volumes which it is contributing to Antarctic knowledge. Four of the new parts are technical contributions to systematic zoology. Prof. Jungersen, of Copenhagen, describes the Pennatulids, which are represented in the collection by eight specimens; all of them are referred to one species, the *Umbellula carpenteri*, first discovered by the *Challenger*. Herr Böhmig, of Graz, describes the Turbellarians, a small but interesting fauna containing a new genus of Acœla and three species of the characteristic sub-Antarctic genus Procerodes. A detailed account is given of the anatomy of these worms, and the author establishes a new genus and subfamily, the Stummerinæ, for a species that had been collected by the French Antarctic Expedition, and referred by Hallez to Procerodes. Herr L. Plate contributes a note on the Scaphopods, which are represented by one determinable and one indeterminable species of Dentalium, both collected south of latitude 70°. The Cirripedes are described by Herr P. P. C. Hoek, and this group is represented by three species, of which one, *Verruca mitra*, is new. They all come from the neighbourhood of the Magellan Straits. But that area does not appear to be rich in these crustacea, and the only known Antarctic species is a Scalpellum collected by the *Challenger* near the Antarctic Circle.

The geographical results include a valuable joint report by M. Arctowski and Dr. H. R. Mill on the serial temperature observations. Ross had attempted to determine the temperature of the deep sea in the same area, but, as is well known, his results were misleading, as his thermometers were not protected against pressure. The *Challenger* thermometers were, of course, guarded against this error, but they recorded only the temperatures of the coldest and warmest of the layers passed through during the sounding. Bruce, in the *Balaena*, was better equipped; but he was only able to determine the temperatures at two localities. The Belgian expedition, however, was able to conduct serial temperature soundings with such precision and in such numbers that the seas which it explored are, as regards temperature distribution, described by Dr. Mill as now one of the best-known parts of the oceans.

The observations show that the distribution of temperature in the seas between South America and Graham Land is typically sub-Antarctic. There is a zone of warm water between a cold surface layer and the mass of cold water below. South of the Antarctic Circle seasonal variations were found to affect the temperature to a depth of only 150 metres. In most localities the coldest water was found at the surface, and the temperatures rose, sometimes regularly, to a maximum in most cases at the depth of about 600 metres. Below that level there is a slow fall in temperature to the sea bottom. The bearing of these observations on submarine topography is shown in Gerlache Strait, where only one serial temperature observation was made; the temperature of the water was almost uniform throughout, and the water was a little colder at the bottom than at the surface. The authors, therefore, conclude that Gerlache Strait is a closed basin, and that a shallow threshold protects it from the inflow of warmer water.

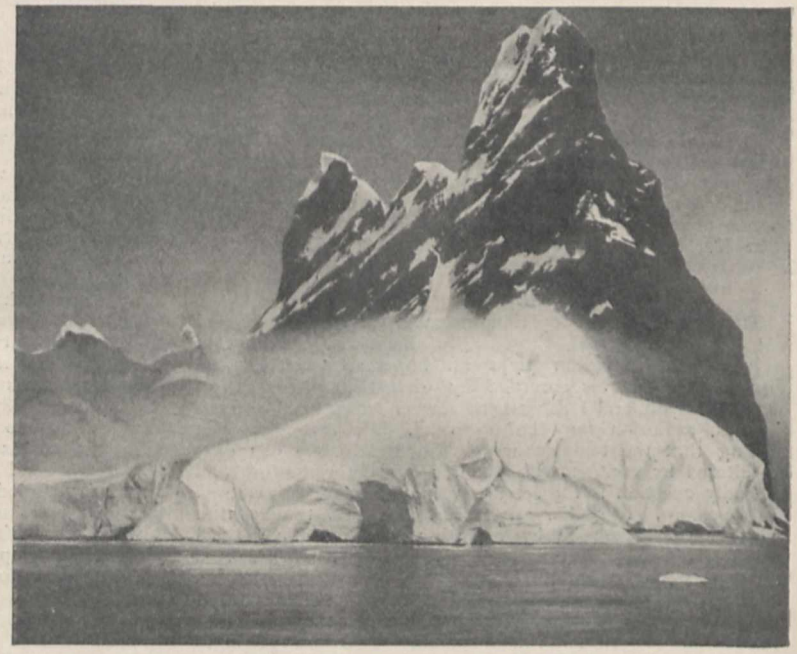

FIG. 1.—Aiguilles of Cape Renard, seen from the North-east.

M. Lecointe, the second in command of the Belgian expedition, contributes a memoir on the pendulum observations. The frontispiece is a photograph of Lieutenant E. Danco, who had charge of this work until his death during the expedition. The memoir gives a detailed account of the instrument employed, Sterneck's half-second pendulum. It was only used during the expedition at one locality, Punta Arenas, in Tierra del Fuego, where the value of g was determined as 9·8108.

The new contribution to the reports of the Belgian expedition of widest general interest is M. Arctowski's valuable report on the glacial observations in the neighbourhood of Magellan's Straits and in the South Shetland Archipelago; and the glaciers and icebergs of those regions are illustrated by eighteen excellent photographic plates. M. Arctowski describes the former greater extension of the glaciers, and regards this as part of a world-wide phenomenon, for which he says the explanation has yet to be found. He adopts ex-

[1] "Résultats du Voyage du S.Y. *Belgica* en 1897-9." G. Lecointe, Physique du Globe, Mesures pendulaires, 1907, 40 pp., 9 figures; P. P. C. Hoek, Zoologie, Cirripedia, 1907, 9 pp., 4 figures; H. F. E. Jungersen, Zoologie, Pennatuliden, 1907, 12 pp., 1 plate; L. Böhmig, Zoologie, Turbellarien, 1908, 32 pp., 2 plates; L. Plate, Zoologie, Scaphopoden, 1908, 4 pp.; H. Arctowski and H. R. Mill, Océanographie, Relations thermiques, Rapport sur les Observations thermométriques faites aux Stations de Sondage, 1908, 36 pp., 4 plates; H. Arctowski, Géologie, Les Glaciers, Glaciers actuels et Vestiges de leur ancienne Extension, 1908, 74 pp., 18 plates. (Anvers: D. E. Buschmann.)

"Deutsche Sudpolar Expedition, 1901-3." Edited by E. von Drygalski. Vol. ii., Kartographie, Geologie; Part ii., 1908, pp. 91-222, plates ix-xxii., and 3 maps. (1) E. Werth, Aufbau und Gestaltung von Kerguelen, pp. 91-183, plates ix-xiv, 33 figures, 3 maps; (2) E. Philippi, Geologische Beobachtungen auf Kerguelen, pp. 185-207, plates xv-xxii, 2 figures; (3) R. Reinisch, Petrographische Beschreibung der Kerguelen-Gesteine, pp. 209-222, 6 figures. (Berlin: G. Reimer, 1908.)

Vol. i., Geographie, Heft ii. Pp. 99-280. Edited by E. von Drygalski. Vol. ii., Geographie, Geologie, part iii., 1908, pp. 223-298, plate xxiii. (1) E. von Drygalski, Geographie von Heard-Eiland, pp. 223-239, plate xxiii., 3 figures; (2) E. Philippi, Geologie der Heard-Insel, pp. 241-250; (3) R. Reinisch, Gesteine der Heard-Insel, pp. 251-263, 8 figures; (4) E. Vanhöffen, Tiere und Pflanzen der Heard-Insel, pp. 265-271; (5) W. Meinardus, Skizze des Klimas der Heard-Insel, pp. 273-298, 2 figures.

treme views on some glacial questions, and holds that the progressive advance of civilisation to the temperate regions from the tropical and subtropical zones is one manifestation of the spread of a milder climate across the earth. Of the suggested theories of glaciation he regards Croll's as the most seductive, but admits that it has fallen with all the rest; nevertheless, he still argues with Croll's wild estimate that the ice at the South Pole is six miles thick, as if that notion were worth serious consideration. Arrhenius's view that glaciation is due to variations in the atmosphere Arctowski rejects as being far from a satisfactory explanation of the facts. His own idea is that the climatic change was due to a variation in the heat supply from the sun.

The memoir begins with a description of the glacial phenomena of the neighbourhood of the Magellan Straits, supplementing the valuable observations in this area by Dr. Otto Nordenskjöld. The second part of the memoir is a valuable contribution to the tectonic and glacial geology of Gerlache Strait. He describes that strait as a tectonic valley, but he is doubtful (p. 34) whether it was formed as a syncline or a rift valley. In dealing with the Antarctic lands, he notes the various forms of the name Antarctica, and suggests that the western section should be called "Westantar," as "Antar" includes all that is common in the various forms of the name Antarctica.

FIG. 2.—View of Royal Sound, Kerguelen.

In his account of the tabular icebergs, M. Arctowski is emphatic as to their identity with the floebergs of the Arctic, and he quotes with approval Greeley's excellent statement of the formation of floebergs. He discusses the question of glacial erosion, and says that his observations show that erosion by glaciers is a mere "minime"; but he remarks that ice has powers of deeper erosion than rivers, as it can erode below sea-level, whereas a river cannot excavate deeper than the level of its mouth. His report concludes with an interesting discussion on the extent of the refrigeration of climate indicated, according to the theory he accepts, by the former extension of glaciers.

A further instalment of the reports of the German Antarctic Expedition includes three instructive memoirs on Kerguelen. Dr. Werth records his additions to the geography of the island during a year's residence, in 1901 and 1902, at a station erected on the Gauss Peninsula in south-eastern Kerguelen to obtain observations for comparison with those simultaneously made by the *Gauss*. Emil Philippi, the geologist of the expedition, records the results of his excursions ashore during the stay of the *Gauss* at Kerguelen, and Dr. Reinisch describes in detail the rock specimens collected there.

Since the discovery of the archipelago by Kerguelen in 1772, and the establishment of its insular nature by Cook in 1775, it has been visited by many expeditions, including the *Erebus* and *Terror*, the *Challenger*, the *Gazelle* and the *Valdivia*, and by private naturalists, such as Hall, the Australian ornithologist. It has also been the resort of seal and whale fishers. Nevertheless, and in spite of the important contributions of the expedition under Drygalski, Kerguelen is still imperfectly known. Dr. Werth made numerous excursions from the station, but the main interior and its glaciers and mountains, were inaccessible to him, and the southern and western coasts he describes as still practically unknown. Dr. Werth's range of work was restricted by the difficulties of transport. His party had at first to carry all their equipment on their backs, and were therefore limited to excursions of about five days' duration. Later on he used dogs, and as each dog carried a pack of twenty pounds, it could take its own rations for ten days, and some supplies for the explorers. In the later part of the stay on the island exploration was unfortunately prevented by illness.

The chief island of the Kerguelen Archipelago is only 130 square geographical miles, and it is divided into three divisions. The western coast lands are still little known, and may contain some centres of recent volcanic activity. The central highlands, running from north-west to south-east across the island, include two high ice-covered plateaus, and culminate at their southern end in Mount Ross, a volcano with a well-preserved crater and 1990 metres high. The third section includes the country on the eastern parts of the island; it is deeply indented by the sea, and is mainly lowland, but it includes one independent mountain complex and some wide plateaus.

The solid geology of Kerguelen is disappointing. It consists of nothing but a vast dissected sheet of basalts, with their associated tuffs, and various glacial and alluvial deposits. There are older trachytic and phonolitic lavas, of which the German expedition obtained traces in beds of sanidine sand. There are no known pre-volcanic sedimentary rocks, and whether Kerguelen is a continental or an oceanic island is left undecided. The physical geography of the island is, therefore, its chief interest. For a land in the latitude of only 48°–50°, it has the remarkably low snow-line of 1850 feet, and its central highlands are covered by an ice sheet which Dr. Werth has named after Richthofen. There is abundant evidence that the glaciers were more extensive, at a date that Dr. Werth calls "diluvial," which may be more recent than the chief glacier extension in north temperate regions. The glaciers certainly formerly reached the present sea-level, and appear to have continued some distance over what is now the sea floor. It is, therefore, disappointing that there is no certain evidence as to the post-Glacial

uplift of the land. Both Werth and Philippi describe the occurrence of recent shingle and shells at heights up to about one hundred metres; but they recognise the possibility of these having been carried inland by sea-gulls or sea elephants. There is abundant evidence of recent subsidence; the eastern district, according to the chart and many beautiful photographs, presents the typical features of a sunken land.

Dr. Werth discusses at length the origin of the valleys and the relations of the two types of drowned valleys known as "fjords" and "fjärds." The distinction between them was established by Penck in 1882; fiords are complex and usually branched valleys in mountainous districts, and fjärds are valleys that are usually parallel to one another, and occur in lowlands. The value of this distinction has been doubted, but Werth thinks it is useful; and he proposes that valleys of the fjärd type should be called "föhrde," after the name given them in southern Denmark, as it has the same root as the Norwegian fjörd, the Swedish fjärd, the Icelandic fjördur, and the Scottish firth.

Denudation in Kerguelen, according to Dr. Werth, is due chiefly to glacial action, for the rivers are insignificant; but Philippi points out that the valleys were pre-Glacial. Consideration of their age necessarily involves that of the lava flows through which they have been cut. In the neighbourhood of the station the eruptions were obviously pre-Glacial; but the crater of Mount Ross must be much younger than the lava flows of the eastern lowlands. The only palæontological evidence of the age of the eruptions is given by some fragments of the stem of Cupressoxylon; but as this conifer ranges from the Upper Cretaceous to the Pliocene, its evidence is not very precise, though the Kerguelen species is regarded as pre-Pleistocene. Wind erosion is exceptionally well exhibited, owing to the violence of the storms and the abundance of loose volcanic débris for the sand blast; the effect of the wind is illustrated by photographs of a carved block of basalt and of some potholes bored by sand erosion on the face of a vertical rock.

The important contributions of the German expeditions to the natural history of Kerguelen show how great are the gaps in our knowledge of that interesting and accessible archipelago, and will, it may be hoped, lead to its fuller investigation.

Heard Island, where the German Expedition spent seven profitable hours ashore, is 330 miles south-east of Kerguelen, and is even less known. Both islands rise from the same submarine plateau, and the reports by Philippi and Reinisch show that they are composed of similar volcanic rocks, for Heard island consists of trachytes, felspar basalts and limburgites. The rocks look less weathered than those of Kerguelen, but Philippi suggests, from the greater abundance of trachyte, that the lavas belong to the earlier period of the Kerguelen eruptions. Prof. Drygalski describes the geography of Heard Island and the seven glaciers on the northern coast, Meinardus contributes a sketch of its climate based on all existing records, with the gaps filled by interpolation from the observations on the *Gauss* and at the station at Kerguelen. In view of the many interesting problems connected with Heard Island, Prof. Drygalski recommends it as a suitable locality for a year's expedition; and as at the visit of the *Challenger* there were forty men on the island who were staying there from October to December, an expedition should be easily practicable and profitable.

J. W. GREGORY.

IRRIGATION IN EGYPT.

The Esneh Dam.

THE construction of the dam on the Nile near Esneh, which has recently been completed, the last stone being laid by the Khedive, marks another step in the progress of that country since it has been under British control. Less than thirty years ago Egypt was on the verge of financial ruin, the annual expenses exceeding the income, and there not being sufficient revenue to pay the interest on the national debt. The peasantry were in a miserable and poverty-stricken condition, and constantly harassed by the continuous calls under the labour conscription, or *corvée*, for the repairs of the banks or the cleansing of the irrigation canals. This system has now been entirely done away with; the small farmers are no longer at the mercy of the money-lender, and are in a prosperous and contented condition. The revenue shows a surplus, and the yield of the crops has been enormously increased.

The leading factor in this change has been the better and more effective management, and the extension of the irrigation works, on which the agriculture of Egypt depends for its existence.

The cultivated portion of Egypt consists of a narrow strip of land bordering on the Nile, extending southward from the Mediterranean Sea. Of this the lower, or southern, district consists of the delta of the Nile below Cairo, forming a triangle, the sides of which are about 100 miles in length, with an area of four million acres, the cultivated portion of which covers $2\frac{3}{4}$ million acres. At the head of this delta the Nile water is held up by the great barrages of Rosetta and Damietta. Above this is Upper Egypt, a tract 500 miles long, lying principally on the west side of the river, and extending nearly to the first cataract above Assouan. The width of the land that is cultivated varies from eight to fourteen miles, the sand of the desert in many places at the upper end reaching close up to the river. The area of the land under cultivation is about $2\frac{1}{2}$ million acres, which is dependent entirely on irrigation. Rainfall in Egypt may be said to be conspicuous by its absence, the average fall at the northern end being $1\frac{1}{2}$ inches, and above this the country is practically rainless.

The Nile is one of the longest rivers in the world, its length from the source to the Mediterranean being more than 3000 miles. Owing to its physical conditions, the fact that it has no tributaries for the last 1500 miles of its course, and the great amount of evaporation under the tropical heat of the sun, it presents the peculiar phenomenon that the quantity of water flowing down the river decreases as the lower length of its course is reached. In floods it carries in suspension detritus derived principally from the volcanic plateau in Abyssinia and the swampy regions of the White Nile. The quantity of material thus transported from the middle of Africa and Abyssinia has been estimated at 62 millions of tons a year, raising the level of the cultivated land in Egypt at the rate of $3\frac{1}{2}$ inches in a century, and to a depth which in some places extends to 30 feet.

The Nile being fed from lands having wet and dry seasons, it has a regular rise and fall, the water through Egypt being at its lowest in June and reaching its maximum in October. The reading of the Nilometer at Rodah is watched with the greatest interest, as the prosperity of the country depends on the height of the flood water. The difference between high and low floods varies about $10\frac{1}{2}$ feet, the mean rise varying from 23 feet at Cairo to 26 feet at Assouan at the upper end. The discharge of this

flood water being greater than is required at high floods and deficient in low floods and in summer, a system of dams at different parts of the river has been carried out for storing and regulating the supply.

The principal crops grown along the Nile are wheat, sugar, cotton, rice, maize, and other smaller vegetation. Where the supply of water is sufficient, two crops can be obtained in one year. The cultivation of cotton is rapidly extending, the value of this crop alone now being nearly as great as the whole revenue of the country.

The first great work for improving the irrigation undertaken by the Works Department after the British obtained control in 1883 was the completion of the great barrage, or dam, at the head of the Delta. This had been constructed by the French engineers for the purpose of holding up the Nile water to a height of 15 feet, sufficient to provide the necessary head for feeding the irrigation canals. Owing, however, to defects in the construction, it had never been possible to raise the level more than 5 feet. Under the direction of Colonel Scott-Moncrieff, the foundations were strengthened, and other necessary repairs carried out, with the result that the full head of water can now be maintained, and the land can be efficiently irrigated. Also, by the construction of another barrage, at a cost of 230,000*l*., half-way between Cairo and the sea, the irrigation is rendered still more effective. Owing to these works the value of the cotton crop has been increased from 7½ to 15 millions of pounds, and the cultivated area increased by a million acres.

For regulating the supply of water in Upper Egypt, about seven years ago the great barrages, or dams, at Assouan and Assiout were built across the river at the head of the cultivated system of Upper Egypt. These works were carried out by the firm of Aird and Co. for the English Irrigation Department, the contract price being 2,000,000*l*. These dams act as regulators of the water supply in summer, and have practically doubled the supply available. It was stated by Lord Cromer, in one of his reports soon after they were completed, that the effect of these works was to increase the rental of the land to 3*l*. an acre, in addition to a tax of 10*s*. that is levied to pay the cost. A practical demonstration of their value was afforded in 1902, when the Nile flood was a very poor one, and the agricultural outlook was very critical, for a large area of cropping was in danger of being entirely lost through want of irrigation. This, however, was prevented, owing to the water stored by the dam at Assiout, and cropping estimated of the value of 500,000*l*. was saved. Thus the whole cost of this dam was paid for in this one season.

The dam recently opened by the Khedive is near Esneh, a town of 25,000 inhabitants, situated on the Nile 643 miles from the Mediterranean and 110 miles below the dam at Assouan. It has been constructed for the purpose of storing the flood water and providing perennial irrigation to a tract of land containing 250,000 acres, on which at present only one crop of cereals can be grown. When irrigated this land will be capable also of growing a second, or summer, and more profitable crop of sugar or cotton.

The dam is somewhat similar in construction to those above described. It consists of a masonry structure containing 119 piers, spaced 16½ feet apart, and connected by arches, on which is carried a roadway across the Nile about half a mile long and 19½ feet wide. The openings between the piers are fitted with upper and lower doors, or gates, resting in grooves, which can be raised or lowered by machinery so as to regulate the discharge of the water through the dam. For the use of the navigation a lock has been provided which is 262½ feet long and 52½ feet wide.

The dam at Assouan rested on the granite bed of the river, but at Esneh the substratum was sand, which extended to a considerable depth below the bed of the river. To carry the structure, therefore, a continuous floor had to be made 2950 feet long and 98½ feet wide. This floor consists of cement concrete 3½ feet thick, on which is 6½ feet of rubble masonry laid in cement and paved with granite setts. To prevent the water finding its way under this floor, when it is held up, two rows of iron sheet piles were driven to a depth of 13 feet below it, 61½ feet apart, across the bed of the river, the space between being filled with clay puddle pitched with limestone. On the down-stream side, to prevent erosion of the river bed by the water pouring through the arches when the doors are open, a floor was laid with a pitching of limestone 131 feet wide.

The superstructure was built of sandstone, granite being used for the lock. This sandstone was obtained from a quarry fifty-seven miles distant, the quantity used amounting to 166,000 cubic yards. The granite, of which 80,000 cubic yards was used, was brought down the Nile in barges from Assouan, a distance of 110 miles. The cement, the iron piles, and the machinery all came from England.

From 8000 to 10,000 natives were employed, Italians being engaged in preparing the stone. The work was supervised by English foremen and overseers.

The preliminary works, including the opening out of the quarries, temporary railways, of which twenty-four miles were used, workshops for the men, and offices, were commenced in the spring of 1906, the permanent work being begun in the following November. Three years were allowed by the contract, and as the work was completed in half the specified time, the district is thus given the benefit of an extra season's irrigation.

The works were designed by Mr. Webb, the engineer of the Egyptian Works Department, under the direction of Mr. Macdonald, the director of reservoirs, and carried out by Messrs. Aird and Co., the same contractors who constructed the Assouan and Assiout dams. The cost was more than 1,000,000*l*.

ELECTROCHEMICAL INDUSTRY.

THE report referred to below[1] is based in the main on information obtained during visits to certain countries in Europe and to the United States and Canada, including British Columbia. The Gartside scholarships were established in 1902 by Mr. J. H. Gartside, and are administered by the University of Manchester. The scholar who obtains the grant must first study in the university, and the remainder of his time must be devoted to an examination of subjects bearing upon commerce or industry in Germany, Switzerland, or the United States of America. It is intended that each scholar shall select some industry or business for examination, and investigate this comparatively in the United Kingdom and abroad.

The report is of particular interest because it deals with a subject which is of comparatively recent growth, and which has remarkable potentialities. In fact, as the author says, few chemical processes have escaped being affected in a greater or less degree by the application of electrical methods.

1 "Some Electrochemical Centres." By J. N. Pring. Being No. 7 of the Gartside Reports on Industry and Commerce. Pp. xiii+137. (Manchester: University Press, 1908.) Price 1*s*. 6*d*. net.

But in this country no revolution has been caused in the chemical industry by the introduction of electrochemical methods. Of course, there are various reasons for this; in the first place, cheap power is a *sine qua non* if an electrochemical process is to be satisfactory. Although we have cheap coal, we have very limited supplies of water power. The heavy chemical industry of this country was also in a very secure and flourishing state, therefore there was not much inducement to try the newer methods. On the contrary, in America the chemical industries were not particularly well established. The water power obtainable from the Niagara is immense, although in this connection it should be borne in mind that nearly all the large electrolytic copper refineries are situated near New York, and are worked by steam power; and the progress in America is due in no small measure to the great enterprise and *superior technical training* of the people.

The first part of the volume discusses the question of cost of power production, comparisons being made between water, steam, oil-engine and gas-engine power. It appears in general that water power is the most economical, and gas engines actuated with blast-furnace gas the next. Chapter ii. deals with the Niagara Falls and the distribution of the power, the chief industries being the Aluminium Co. of America, Carborundum Co., Union Carbide Co., Castner Kellner Electrolytic Alkali Co., Oldbury Electrochemical Co., Acheson Graphite Co., and Niagara Electrochemical Co., which take between them about 68,500 h.p. One of the most interesting industries which entirely owes its origin to electrical power is the manufacture of abrasives—carborundum and alundum. There is also the flourishing artificial graphite works. The aluminium works employ about 35,000 h.p., and hold practically the monopoly of the aluminium manufacture in the U.S.A. and Canada. A large part of the power developed from the Niagara is employed for electrochemical purposes on the Canadian side of the falls.

The descriptions of the power obtained from the various falls and rapids is narrated in a very interesting manner. Chapter v. treats of the electric smelting of iron ores and steel production. The electrochemical industries in the Alps, France, and Belgium are also dealt with. In the Alps there are a large number of comparatively small falls, and it says a great deal for the skill of the French engineers that so much use has been made of them, rendering France the chief seat of the electric alloy manufacture. The last chapter describes the electrochemical industries in Great Britain, and anyone reading the book will probably find that there is more work being done in this direction than is generally considered to be the case. The origin of the electrolytic refining of copper was in this country, where it was founded in 1869 by J. Elkington, and the works erected at Pembury, in Wales, are still in operation, although, naturally, they have been enlarged. We congratulate the author upon a very readable and painstaking production.

F. M. P.

NOTES.

WE regret to announce the death, on February 13, of Sir George King, K.C.I.E., F.R.S., late director of the Botanical Survey of India, in his sixty-ninth year; also of Prof. Julius Thomsen, president of the Royal Danish Society of Science, at eighty-two years of age.

A REUTER message from Washington states that the Smithsonian Institution has decided to award the first Langley gold medal to Messrs. Wilbur and Orville Wright.

THE Berlin Academy of Sciences has awarded the Helmholtz medal to Prof. Emil Fischer, for his work on the sugars and albuminoids.

IT is announced that an international exhibition is to be held at Brescia from August to October next under the patronage of the King of Italy.

THE Prehistoric Society of France has elected Dr. A. Guebhard president for 1909; MM. Marot and Viré become vice-presidents, Dr. Marcel Baudouin general secretary, and M. L. Giraux treasurer.

THE *Petit Journal* recently asked its readers to select by their votes twelve great Frenchmen worthy of being included in the Pantheon. Pasteur's name appeared at the top of the poll with 315,203 votes, and was followed by that of Gambetta with 279,443 votes. We wonder whether a man of science would head the list if a similar plebiscite were taken by a popular daily paper in this country.

THE proposed amalgamation of the London Institution with the Society of Arts on the lines of a scheme drawn up by a joint committee in 1905 has been approved by a majority of the proprietors of the former institution. A ballot taken on Monday showed as the result:—for amalgamation, 322; against, 218, the majority in favour thus being 104. The board of management has now to consider whether action shall be taken to carry out the scheme for amalgamation.

THE council of the Royal Society of Arts attended at Marlborough House on February 11, when the Prince of Wales, president of the society, presented its Albert medal to Sir James Dewar, F.R.S., "for his investigations into the liquefaction of gases and the properties of matter at low temperatures, investigations which have resulted in the production of the lowest temperatures yet reached, the use of vacuum vessels for thermal isolation, and the application of cooled charcoal to the separation of gaseous mixtures and to the production of high vacua."

AT the annual meeting of the Royal Astronomical Society on February 12, the following were elected as the officers and council for the ensuing year:—*President*, Sir David Gill, K.C.B., F.R.S.; *vice-presidents*, Sir W. H. M. Christie, K.C.B., F.R.S., Dr. J. W. L. Glaisher, F.R.S., Mr. H. F. Newall, F.R.S., Prof. H. H. Turner, F.R.S.; *treasurer*, Major E. H. Hills, C.M.G.; *secretaries*, Mr. A. R. Hinks, Mr. S. A. Saunder; *foreign secretary*, Sir William Huggins, K.C.B., O.M., F.R.S.; *council*, Mr. Bryan Cookson, Rev. A. L. Cortie, Mr. A. C. D. Crommelin, Mr. A. S. Eddington, Prof. A. Fowler, Mr. J. A. Hardcastle, Mr. H. P. Hollis, Mr. E. B. Knobel, Mr. T. Lewis, Major P. A. MacMahon, F.R.S., Mr. W. H. Maw, Prof. R. A. Sampson, F.R.S.

SEVERE earthquake shocks were experienced again at Messina and in Calabria on February 12 and 13. The *Daily Chronicle* Milan correspondent reports the chief shock as occurring on February 13 at 8 p.m., and lasting for ten seconds, the shock being accompanied by noises like that of cannon during a heavy bombardment. A Reuter's message from St. Petersburg states that a slight earthquake shock was felt on February 13, at 8 a.m., at Sotchi, in the Government of Suchum. Another message from Mexico City reports that the volcano of Colima, near the town of that name, was erupting with increasing violence on February 13. Loud subterranean detonations were heard, and showers of hot ashes fell. A stream of

lava a mile long is said to have been emitted from the crater. On February 16 severe earthquake shocks were felt in southern Bulgaria and parts of Hungary.

THE Prince and Princess of Wales were present at the Royal College of Surgeons on Monday, when Mr. Henry Morris, the president, delivered the Hunterian oration, taking as his subject "John Hunter as a Philosopher." The Prince has accepted the diploma of honorary fellow of the college, and on Monday he signed the roll. The president, in the course of his address, said a study of Hunter's works shows that he combined in an exceptional degree the two philosophic methods of induction and deduction. He was essentially a thinker rather than a scholar, yet an experimental philosopher rather than a metaphysician. He saw that for a complete scheme of knowledge induction and deduction are supplementary to each other. His adoption of both inductive and deductive methods was the result of two causes—the natural scope and bent of his mind and the nature of the subjects to which he devoted his life. Induction was largely the method required for the profession he chose. Hunter was a disciple of Bacon in that he employed induction in the pursuit of truth with an ulterior regard to utility and the good of mankind. At the same time he had not the deductive force of Descartes. It was not as a logician, but as an observer and experimenter that Hunter excelled; it was not the beauty of his logic, but the industry with which he collected facts, and the ability and honesty with which he reasoned from them, that made him great.

IT is announced in *Science* that Mr. D. C. Sowers, in charge of the special magnetic expedition to China under the auspices of the Carnegie Institution of Washington, left Peking on January 30. He will be assisted by Prof. Chester G. Fuson, professor of history and geography at the Canton Christian College. The route to be followed by the party will touch at the following places:—Sianfu, Lanchowfu, Suchow, Turfan, Kashgar, Khotan, thence, *viâ* the Karakorum Pass, into India, where connection will be made at Dehra Dun with the magnetic survey of India. Magnetic observations will, therefore, be obtained in parts of China and Chinese Turkestan where no previous data existed. Dr. J. C. Beattie, director of the department of physics, South African College, Cape Town, has been granted a year's furlough in order to take charge of a magnetic survey party under the auspices of the Carnegie Institution. He left Cape Town on November 25 last. His general route of travel will be through German South-West Africa, thence into Rhodesia, British East Africa, German East Africa, and next through Nubia and Egypt, connecting with the magnetic survey of Egypt at Cairo. He will be assisted by Prof. J. T. Morrison, in charge of the department of physics, Victoria College, Stellenbosch, South Africa, who will confine his work chiefly to points reached by steamer along the east and west coasts of Africa. Mr. J. C. Pearson, who during the past year has been engaged in making magnetic observations in various parts of Persia under the auspices of the Carnegie Institution, will be ready some time in March to undertake similar work in Asia Minor, beginning at Bagdad.

MESSRS. H. W. COX AND CO., LTD., of 47 Gray's Inn Road, London, W.C., point out in a circular letter that the exaggerated reports which have appeared consequent upon the sufferings of some of the earliest workers with Röntgen rays (including Mr. Cox himself) have affected not only the English manufacturer and the medical man who were sufficiently enterprising to take up the new treatment, but also to a considerable extent deprived the public of the benefit of the discovery which has been of such incalculable value in the relief of suffering and the advancement of medical knowledge. It should now be well known, however, that apparatus has been devised which entirely obviates any danger either to the patient or to the operator, while experiments have determined the maximum exposure which may be given with safety to the human skin. The rays are now used with perfect safety in thousands of hospitals throughout the world in the treatment of various diseases. Mr. Mackenzie Davidson long ago exhibited at the Röntgen Society the method of protection from the injurious effects of X-rays advised by him. It simply consisted of a wooden box thickly coated with red and white lead mixed into a thick paste—this hardened, and was a non-conductor. A circular opening was left opposite the antikathode. Thus everyone was protected from these rays except the patient who was placed in the path of the rays. Further, the viewing fluorescent screen should be framed and covered with thick and heavy plate glass, which does not interfere with the screen except to protect it (as the glass does a framed picture), and shields the observer from injurious rays. Had these simple precautions been carried out, we should not be grieved by these maimed martyrs. Of course, any material of sufficient atomic weight can be used to enclose the X-ray tube.

A COPY of the annual report for the year 1908 of the council of the Philosophical Institute of Canterbury, N.Z., has been received. During the year arrangements have been under consideration for the publication of the report of the expedition to the subantarctic islands of New Zealand, which took place in 1907 under the auspices of the institute. The expedition was assisted by the Government, and 500*l.* was received from the same source towards bringing out the report on the expedition. Other important questions which have occupied the attention of the council include experiments in connection with Arthur's Pass Tunnel, the foundation of a library of Antarctic literature, the dispatch of a scientific party to the Chatham Islands, and the more adequate protection of native fauna. The Government of the Dominion of New Zealand has made a grant of 200*l.* towards the earth-temperature observations at Arthur's Pass Tunnel, and we notice the council puts on record its indebtedness to Prof. Heim, of Zürich, for the help and advice he has rendered the subcommittee in charge of these experiments. The council recommends that a party of men of science be sent at the first opportunity to the Chatham Islands to make collections of articles of ethnological interest and of specimens of the subfossil bird remains. In connection with the protection of native fauna, it has been decided to direct the attention of the Minister of the Interior to the fact that neither the kaka nor the tuatara is protected, though the export of specimens of the latter is forbidden.

THE Journal of the Royal Sanitary Institute for February (xxx., No. 1) contains a valuable paper by Dr. Rideal on the purification of water by ozone by the De Frise process, which is considered to give extremely satisfactory results.

IN the Bulletin of the Johns Hopkins Hospital for January (xx., No. 214) another paper on the history of medicine is added to the series already published in this journal, the subject being John James Wepfer, a Renaissance student of apoplexy, contributed by Dr. John Donley.

THE Royal Commission on Tuberculosis recently issued a third interim report (Cd. 4483, price 4*d.*). In their second interim report the commissioners expressed the

opinion that a considerable amount of disease and loss of life, especially among infants and children, must be attributed to the consumption of cows' milk derived from tuberculous udders and containing tubercle bacilli. The present report contains an account of experiments which have been carried on regarding the infectivity of the milk and fæces of cows which have contracted the disease in the ordinary way. None of the cows investigated showed any sign of tuberculosis of the udder during life, and one only *post-mortem*, yet the milk of these cows contained tubercle bacilli. It was also found that cows affected even with slight tuberculous lesions discharge tubercle bacilli in small numbers in the fæces; those with extensive tuberculous lesions of the lungs or alimentary tract may discharge large numbers of bacilli from the mouth or nostrils in coughing or in the fæces. Since dirt of various kinds from the cow-sheds is almost constantly present in milk as it reaches the consumer, another possible mode of human infection is indicated.

THE greater part of the January issue of the *Museums' Journal* is occupied by papers on the Norwich Museum Association and on a new method of keeping Lepidoptera, both of which were read last year at the Ipswich conference. The system of keeping butterflies and moths, which Mr. S. L. Mosley claims to possess great advantages, is based on devoting a separate box—made in book-form—to each species, with all its phases and variations, as well as illustrations of its natural surroundings and maps of its distribution. The boxes can be arranged on shelves like books.

PROF. RINA MONTI, writing in the Lombardy *Rendiconti*, xli., 18, discusses the active and passive migrations of the fauna of the Italian Alpine lakes. The author finds that on the south side of the Alps the migrations from valley to mountain should have been less easy at the end of the Glacial epoch than at present, on account of certain geo-hydrographical considerations which he has examined. The passage of boreal types from north to south must necessarily have taken place through depressions in the dividing chain, and the author advances arguments against the hypothesis of an active migration. In several lakes of recent origin of the Ruitor, formed by the regression of glaciers, the author finds that the fauna have migrated from neighbouring basins.

THE whole of the first part, comprising 170 pages of text and twenty-four plates, of the fifth volume of the Zoological Publications of the University of California is devoted to the results of a biological survey, by Mr. Joseph Grinnel, of the San Bernadino Mountains of southern California. These mountains, in the restricted sense of the term, form the most extensive high range in the south of California, and include the highest peak to the south of Mount Whitney. As a large portion is clothed with forest, while the range is isolated from any other mountain-group of approximately similar altitude, the area is one which might naturally be expected to yield results of considerable biological interest. The author paid particular attention to the division of the range into vertical life-zones, which include the Upper and Lower Sonoran, the Transitional, and the Boreal. It was found, as might have been expected, that the flora afforded by far the better data for the delimitation of these zones. Among the special features in the habits of the fauna is the fact that the birds which have bred in the spring and early summer at comparatively low levels are compelled in July to move higher up the mountains in order to escape the shortage of food which prevails, owing to the drought, in their breeding haunts from the commencement of that month until the end of October. A remarkable mortality among the Audubon's warblers was also noticed in December and January; as all these were in an emaciated condition, the lack of proper food would appear to be the cause of the deaths.

DOES the kidney form an internal secretion? is a question upon which physiologists are uncertain. It is stated that extracts of kidney tissue produce a rise of blood pressure; but the main experiments relied upon by those who answer the question in the affirmative were performed some years ago by Dr. J. Rose Bradford, in which he showed that, after removal of a large amount of kidney tissue (the whole of one kidney and a considerable piece of the other), dogs exhibit symptoms of malnutrition which cannot be explained by the loss of the external secretion, the urine. Indeed, the volume of the urine, and the amount of urea excreted, are very frequently higher than the normal in such animals. These experiments were repeated by Bainbridge and Beddard at Guy's Hospital on cats, and their findings did not confirm the far-reaching conclusions which were drawn from Bradford's experiments. The symptoms of malnutrition, according to these later observers, are simply those ordinarily found in inanition, and this condition was present in the cats owing to their refusal to take food. Very similar experiments have just been performed by two American observers, Drs. Sampson and Pearce (*Journal of Experimental Medicine*, New York, vol. x., No. 6, November, 1908). They show that in dogs a reduction of the kidney tissue to one-quarter the original amount is not necessarily fatal, and this is a very important discovery in view of the frequency of surgical operations on the kidney. Very extensive removal of pieces of the kidney is followed by rapid healing, and very little effect on the remaining kidney tissue is noticeable. In cases where a fatal termination did take place, there was renal insufficiency, and the animal refused food. The general trend of the results is therefore in favour of the views of Beddard and Bainbridge.

IN the *Contemporary Review* for February Dr. Havelock Ellis discusses the evolution of the feeling of love of wild nature, that is to say, scenery from which man is excluded. He finds the germ of it in the conception of mingled love and horror felt by the savage towards mountain and woodland, the one the natural home of his gods, the other the abode of malevolent spirits. The affection of his votaries for a god of the wild, like Apollo of Delphi, might in process of time extend to his chosen seat. In Europe the love of scenery first appears among the Celts towards the western isles of Scotland. In classical times the charming, luxuriant landscape of Italy was more fitted to win the admiration of men than the terrible and dramatic aspects of Greece. This became more apparent in the days of the Empire, when Nero chose Subiaco as his abode, and Marcus Aurelius retired for meditation to mountain or sea. Early Christian literature shows little sense of this feeling, but the hermits, who in a state of religious exaltation fled to the desert, fostered at least a tolerance of their barren surroundings. The Christians, again, took over from paganism many sites consecrated to the worship of the gods on account of the remarkable character or beauty of their situation, and religious orders, like the monks of the Grand Chartreuse, were obliged to accept grants of barren lands worthless to their owners. The modern taste for wild scenery was the offspring of the Italian Renaissance, which only revived the views of earlier writers, like the younger Pliny. Coming to more modern days, Addison

shows an advancing but still incomplete appreciation of Alpine scenery, which was further developed by the solitary, imaginative Gray. It was left to Rousseau, in "La Nouvelle Heloise," to popularise that feeling in Europe, the tradition of which passed on to Wordsworth, Byron, and their many successors. While, then, it is incorrect to regard the love of wild nature as an almost universal human instinct, there is evidence that it was felt by the more imaginative minds from the very earliest times.

MR. D. GRIFFITHS contributes to the annual report of the Missouri Botanical Gardens (vol. xix.) a first series of illustrated studies on the genus Opuntia that acquires additional interest because the plants have been studied in their natural localities. Types of several new species, chiefly Mexican, are described.

WITH the present issue, for February, *Irish Gardening* completes its third year, and may well claim to have fulfilled its purpose of providing a source of information for Irish cultivators. An article of general interest to cultivators of rock gardens, on the subject of suitable dwarf shrubs, is contributed by Mr. J. W. Besant. Attractive colouring of leaves, flowers or fruit, in addition to dwarf habit, are the qualities recommended. The author presents a selection of species from about ten genera, among which *Berberis Wilsonae*, a new introduction from China, *Cotoneaster adpressa*, varieties of *Euonymus radicans*, *Genista tinctoria*, *Hypericum moserianum*, *Potentilla Friedrichsoni*, and *Perovskia atriplicifolia* receive special commendation.

MR. G. A. NADSON contributes to the *Bulletin du Jardin impérial botanique*, St. Petersburg (vol. viii., parts v. and vi.), a short article on the physiology of luminous bacteria, regarding the action of salt in cultural media. Luminosity is produced quickly by using a strong solution containing about 3 per cent. of salt, but a solution containing one-half per cent. eventually produces a more intense light. The following method for obtaining the spores of *Saccharomyces cerevisiae* is recommended by Mr. A. A. Gorodkowa. Sowings of pure yeast are made on plates of agar prepared from a solution containing 1 per cent. each of agar, peptone, and meat extract, a half per cent. of salt, and a quarter per cent. of glucose. The cultures, placed in a thermostat maintained at a temperature of 28° C., should produce spores in three or four days.

ON the question of sense-organs in plants, botanists are primarily indebted to Prof. Haberlandt and Dr. Nemec for original conceptions that have met with considerable, but not universal, acceptation. Arising out of a lecture delivered in Berlin, Prof. Haberlandt has published an article on the subject in *Himmel und Erde* (December, 1908, January, 1909). Three different classes of sense-organs are described, concerned respectively with the perception of mechanical, gravitational, and heliotropic stimuli. The arrangement, in the first case, often consists of a projecting cell or portion of a cell, as in the stamens of *Portulaca grandiflora*; more remarkable is the staminal filament of *Sparmannia africana*, that is notched on the receptive side. The theory that starch grains act as mechanical regulators of gravitational stimulation has aroused much criticism, but has been put to a convincing experimental test by Dr. Francis Darwin. Finally, Prof. Haberlandt submits the arguments in favour of regarding lens-shaped epidermal cells and similar structures in the leaves as apparatus for concentrating the light on the protoplasm, and so regulating the position of the leaf.

THE December (1908) number of the *Journal of Agriculture of South Australia* contains the official estimate of the probable wheat harvest for 1908–9 in South Australia. The total yield is placed at just under 20 million bushels, an average of 11·6 bushels per acre. The corresponding actual figures for last year were a little more than 19 million bushels, with an average of 10·9 bushels per acre. The total area under wheat is estimated at 2,062,000 acres, an increase of 37,000 acres over the previous year, but some of this is grown as a hay crop. The area reaped for grain is placed at 1,727,000 acres, a decrease of 26,000 acres; the area cut for hay is 334,000 acres, an increase of 63,000 acres.

THE report on the Botanic Station, Agricultural School, and Experiment Plots of St. Lucia, recently issued by the Imperial Commissioner of Agriculture for the West Indies, shows satisfactory progress. A large number of economic plants have been raised, and nearly 75,000 were distributed, including lime plants, which were most in request, cacao, rubber, the demand for which fell off, mangoes, oranges, &c. Experiments are recorded on cultivation and spraying; it was found that lime trees could be sprayed with an emulsion of kerosene sufficiently strong to destroy the orange snow scale (*Chionaspis citri*) without themselves suffering any harm.

THE varieties of potatoes grown in the Central Provinces of India are described by Mr. G. Evans in a bulletin issued by the Department of Agriculture for the Central Provinces. Until four or five years ago the Moolki variety was the only one grown in certain districts, and there is evidence to show that it had been grown for nearly 100 years without change of seed or climate; it is now, however, said to be "worn out," and rapidly succumbing to attacks of disease, &c. Potatoes are not uncommonly displacing sugar-canes, and are found to be more profitable.

IN vol. xxiii. of the *Queensland Geographical Journal* Mr. H. R. Mathews, without any reference to, and apparently quite independently of, the papers by Mr. N. W. Thomas in vols. xxxv. and xxxvi. of the Journal of the Royal Anthropological Institute, discusses the methods of navigation among the aborigines of Australia. He dismisses the catamarans and dug-outs used in Cape York Peninsula, Port Darwin, and other northern parts of the continent because he refuses to admit that they are of Australian origin, and attributes the introduction of these types to Malays or Papuans, the former race being probably responsible for the more elaborate decoration of bark canoes in the same territory. It is not quite clear whether he intends to found any ethnological speculations on the fact that the custom of men swimming and towing rafts is found at Macquarie Harbour, on the western coast of Tasmania, and at Peterson Bay, in North Australia. It seems obvious, however, that this is a device which, like the materials and forms of the rafts in use at these places, 1800 miles apart, might be independently discovered by natives employing these primitive methods of navigation.

THE extensive literature dealing with American basketry unfortunately seems to be little known among art students and managers of industrial schools in this country, yet both these classes might with advantage consult it in their search for new schemes of decoration and for instruction in the technique of an art which has been brought to such a high degree of perfection by the Indian tribes. The last monograph on the art, as practised by the Pomo tribe in California, is that contributed to the seventh volume of the Publications of the University of California by Mr.

S. A. Barrett. The fibres used, except the bark of the red-bud, are drawn from the roots of plants and trees such as the sedge, carex, and pine. For the foundation material the slender stems of the willow are almost exclusively employed, while for the purposes of decoration the use of feathers and beads is one of its most characteristic features. In technique three different methods are in vogue, coiling, twisting, and wicker-work, of each of which there are numerous varieties. The complexity of the patterns, based on simple geometrical elements such as the line, triangle, rectangle, and rhomboid, is remarkable. To these elaborate patterns, each provided with a descriptive title founded upon some real or fancied likeness to some object bearing the same name, this tribe does not, as is the case with many of their neighbours, attach any religious or symbolic meaning. The numerous drawings accompanying this monograph entitle it to rank as an authoritative manual of this interesting form of artistic handicraft.

DR. HERGESELL, president of the International Commission for Scientific Aëronautics, has sent us a preliminary statement of the participation of the various countries in the work of investigating the upper air, from January to the beginning of July, 1908. Ascents were made in the early part of each of those months, with more or less regularity, from thirty-three stations, including two in the United States and one in Egypt, by means of kites, manned, captive, unmanned (registering), and pilot balloons. The latter do not carry instruments, but observations of wind direction at various altitudes are made by watching the balloons with theodolites. The registering balloons at many of the stations reached altitudes exceeding 18,000 metres; at Pyrton Hill (Oxfordshire) altitudes of 19,000 metres, and at Uccle several exceeding 20,000 metres, were attained. In compliance with a decision of the meeting of the commission held at Milan in 1906, an extended series of ascents took place, for the second time, at the end of July, 1908. The full results will be published later; a preliminary notice of some of them was given in our issue of December 31, 1908.

WE have received the Journal of the Meteorological Society of Japan for the months August to November, 1908; abstracts of most of the papers are given in English. The following seem to us to be of especial interest:—(1) Observation of *Givre* in Hokkaido, by Mr. J. Yamada, in the August number. This is one of the terms left to the International Meteorological Committee to define in a precise manner. In the present paper it relates to the phenomenon sometimes called "rime," and which the author explains is formed after fog of some duration, and most frequently with temperatures below −10° C. (2) The relation of barometric pressure to the pulsation of the earth, by Mr. N. Shimono, in the September number. The seismograph at Osaka showed that the oscillations became more frequent as barometric depressions approached, and decreased as they passed away. No relation was found between the wind and the pulsatory oscillation. We regret to note the death of the president of the society, Vice-Admiral Viscount T. Enomoto, which occurred in October last.

AN interesting table showing the efficiency of various kinds of furnaces is given by Mr. J. W. Hall in a paper appearing in the Proceedings of the Birmingham Metallurgical Society for 1907–8. The difference shown between different types of furnaces is very marked. The highest efficiency in ordinary work is attained by an English blast-furnace making pig iron, in which 81·7 per cent. of the total heat given by the fuel is utilised and only 18·3 per cent. wasted. No less than 65·3 per cent. of the total heat, however, escapes from the furnace, but most of this is recovered outside in various ways. In a puddling furnace not fitted to a boiler, 91 per cent. of the heat is wasted, but the most wasteful furnace of all is the common coke crucible furnace employed in melting steel, in which 1·43 per cent. of the heat is used in the furnace and 98·57 per cent. wasted. Other papers printed in full in the Proceedings deal with the selection and testing of foundry irons, the sampling of pig iron, and the microstructure of a cartridge case.

AN important paper on heat-flow and temperature-distribution in the gas engine was read by Prof. B. Hopkinson at the Institution of Civil Engineers on February 2. The author first investigates the probable heat-flow and temperature-distribution and gradients over the cylinder walls, dealing specially with those parts which are not water-jacketed, and then describes some experiments made on a 40 B.H.P. Crossley gas engine in his laboratory at the University of Cambridge. The temperatures at different parts of the piston, which was uncooled, and also of the exhaust and inlet valves, were measured by thermocouples. Under normal working conditions these temperatures were found to be in excess of the jacket-water temperature by 370° C. at the centre of the piston, 400° C. in the exhaust valve, and 250° C. in the inlet valve. It is very unlikely, as shown by Prof. Hopkinson's calculations, that the temperature of the inner side of water-cooled walls ever rises above quite a moderate value. There may be a temperature gradient in the piston face from centre to edge of 180° C., producing inequality of expansion which may give hoop stresses amounting to several tons per square inch. The author gives an interesting investigation of this problem. Experiments were made in order to ascertain the effects on the temperature-distribution of changing the strength of mixture, time of ignition, and degree of compression. An important set of experiments was also made on the phenomena of pre-ignition produced by overheating of part of the metal surface. A long iron bolt was introduced having a thermocouple at its end. The end of this bolt was heated from the explosions, when it was found that pre-ignition would not occur so long as the bolt temperature did not exceed 700° C. If the temperature exceeded 730° C. pre-ignitions occurred so frequently as to pull the engine up. It was found that the line of division between the conditions under which safe and continuous running was possible and those under which the engine was bound to pull up was very narrow, and can be represented by an increase in the gas charge of only 1 per cent.

WE have received from the Société française de Physique a circular directing attention to the advantages offered by the society to its members, who already number more than fifteen hundred. The subscription for members in this country is only ten francs, and for this a member receives the fortnightly abstracts of communications made to the society, and the quarterly bulletin containing the complete papers. By paying three francs extra a member may have the *Journal de Physique* instead of the bulletin, and as the journal contains both the communications made to the society and abstracts of communications made to many other French, British, and German societies, this is a very inexpensive way of being kept up to date in matters physical. There are other advantages of membership which may be learnt from the secretary of the society, 44 rue de Rennes, Paris.

THE only means of measuring very small gas pressures below one-thousandth of a millimetre of mercury has up

to the present been the McLeod gauge, the accuracy of which was called in question by the work of Sir William Ramsay more than a dozen years ago. In the January number of the *Verhandlungen der deutschen physikalischen Gesellschaft*, Drs. K. Scheel and W. Heuse, of the Reichsanstalt, describe a manometer they have constructed which allows them to measure small differences of pressure to an accuracy of about 0·00001 millimetre of mercury. The instrument consists of two metal reservoirs of small volume separated from each other by a membrane of copper 26 centimetres diameter and 0·03 millimetre thick, which bends under any difference of pressure in the two reservoirs by an amount proportional to the difference. The movement of its centre is measured by the aid of a Fizeau interferometer. By means of this instrument the authors have verified Boyle's law for air down to a pressure of 0·0001 millimetre of mercury, and have shown that the McLeod gauge will give trustworthy results at these low pressures.

THE Watkins Meter Co., of Hereford, has published a fourth edition of the useful "Watkins Manual of Exposure and Development," by Mr. Alfred Watkins. The little book, which contains an abundance of practical information, is sold at 1*s.* net.

THE fifth annual issue of M. Max de Nansouty's "Actualités scientifiques" has been published by MM. Schleicher Frères, of Paris. The volume contains a series of essays on scientific subjects of current interest, which range over the whole field of natural knowledge. It would be difficult to imagine a more interesting way for the student of science to keep up his knowledge of French, and at the same time revise and extend his acquaintance with recent work in his own particular subject of study. The price of the volume is 3.50 francs.

THE Dorset Natural History and Antiquarian Field Club offer the "Cecil" silver medal, and prize of the approximate value of 5*l.*, for the best paper on "The Discovery of Radium: its Probable Origin, Present Development, and Possible Future Use." The competition is open to any person who was between the ages of eighteen and thirty on May 12, 1908, and was either born in Dorset or resided in the county for twelve months previous to that date. Papers should be sent by March 1 to Mr. Nelson M. Richardson, of Montevideo, near Weymouth.

OUR ASTRONOMICAL COLUMN.

INTERACTION OF SUN-SPOTS.—In a paper published in No. 1, vol. xxix., of the *Astrophysical Journal* (p. 40, January), Messrs. P. Fox and G. Abetti discuss a number of observations which lead to the conclusion that in many individual cases, if not in general, there exists a physical connection between different groups of sun-spots.

A preliminary examination of Carrington's and of Spoerer's results showed that the coincidences of longitude in spots of different latitudes were no more numerous than would be called for by the probability of chance coincidence.

An examination of the Rumford spectroheliograms, taking into account, not only the coincidences of spots with spots, but also of spots with disturbed, flocculic, areas, showed that the coincidences were rather more numerous than demanded by chance, but the result was still indefinite.

However, when individual cases were considered, it at once became evident, from an examination of spectroheliograms, that separate spots, in about the same longitude but in opposite hemispheres, were physically connected. One example, illustrated by reproductions, shows the development of a spot (Greenwich, No. 6185) as a northern companion of a southern spot (Greenwich, No. 6184) between May 6 and May 13, 1907.

A more striking interaction is shown by a series of Hα spectroheliograms taken on September 10, 1908, on which violent eruptions are shown in connection with two spots in opposite hemispheres, these eruptions culminating in the gap between the spots being bridged over. Visual observations made during the four hours in which the whole of the display took place showed violent eruptions of hydrogen in the neighbourhood of the spots. Measurements of position indicated that between September 8 and 12 the northern spot advanced 3°·3 in longitude and 1°·7 in latitude towards the southern spot, the latter remaining stationary.

DISTRIBUTION OF THE STARS.—A result having an important bearing on questions relating to the distribution of stars is announced by Prof. E. C. Pickering in Circular No. 147 of the Harvard College Observatory.

An analysis of the Revised Photometry is now being carried out at Harvard, and among other results already obtained the following is held to be of sufficient importance to call for immediate publication.

If the stars were infinite in number and distributed at random throughout space, the number, N, in any given class brighter than magnitude, M, should be given by the formula $N = aM + b$, where $a = 0{\cdot}60$, and b is another constant. A previous determination of a, considering 4000 bright stars, gave the value 0·52, and the deficiency was attributed to the absorption of light by some interstellar medium.

In the present investigation the stars brighter than magnitude 6·50 were divided into six magnitude-groups, and then into two divisions. The one division included the spectral classes A and F (Type i.), the second included the classes G, K, and M (Types ii. and iii.), and it was found that whilst for the first $a = 0{\cdot}60$, for the second its value was only 0·51. From this result it is obvious that in any study of stellar distribution it is essential that the stars must first be classified according to their spectra.

JUPITER'S SEVENTH AND EIGHTH SATELLITES.—In No. 4300 of the *Astronomische Nachrichten* (p. 63, February 2) Sir William Christie publishes an ephemeris for J viii. computed from the elements previously published by Messrs. Cowell and Crommelin. This ephemeris gives the distance Satellite viii.—Jupiter, in R.A. and declination, for every fourth day between January 2 and March 19, the values given for February 19, for example, being −7m. 34·8s. and −4′ 46″. Two photographs taken at Greenwich on January 16 gave the correction +10·3s., +2′ 40″; a second photograph was secured on January 19.

No photograph of J vii. has yet been obtained, every available opportunity having been employed to photograph the more recently discovered satellite. It is understood that an ephemeris for J vii. will appear in the second edition of the American N.A., 1909.

THE ANOMALIES OF REFRACTION.—In determining time by their circumzenithal apparatus, MM. Fr. Nušl and J. J. Frič found a discordance which they attributed to perturbations of the atmosphere lasting over an appreciable period. Whilst the small evanescent anomalies of refraction affected their observations to some extent, it was found that there was a superimposed anomaly the period of which would amount to seconds.

By an ingenious application of photography to their method, they have now succeeded in demonstrating the existence of this second anomaly, and find its period to be of the order of twenty seconds, whilst the amplitude of the movement it causes is about 1″ of arc.

The results, and the methods by which they were obtained, are discussed and illustrated in No. 13, 1908, of the *Bulletin international de l'Académie des Sciences de Bohême*.

THE STORY OF THE TELESCOPE.—In view of the tercentenary of the telescope, Mr. Mee has issued a very interesting little brochure, in which he reviews the more important events in the development of the instrument. He also adds useful lists of observatories, large telescopes, astronomical societies, &c., and tabulates the chief astronomical events since the death of Copernicus in 1543. This work can be obtained from the author, Llanishen, Cardiff, price 6*d.*

REGIONAL AND STRATIGRAPHICAL GEOLOGY.

AMONG the latest memoirs published by the Geological Survey of Great Britain in 1908 are three dealing with familiar ground. Mr. C. Fox-Strangways writes on "The Geology of the Country North and East of Harrogate" (price 2*s*. 6*d*.), in explanation of Sheet 62. A geological map of the district round Harrogate is inserted as a plate in the memoir, and the photographic views, including the famous dropping well of Knaresborough, will interest visitors who may not be specialists. There is a chapter on the history and origin of the Harrogate springs, which are held to arise from independent sources in the hills west of the town, obtaining their chemical ingredients as they pass through the Lower Carboniferous strata towards the spots where they emerge. These strata are provisionally retained as Yoredale beds.

Messrs. A. J. Jukes-Browne and H. J. Osborne White, in explanation of Sheet 254, write of "The Country around Henley-on-Thames and Wallingford" (price 2*s*.). The colour-printed map (price 1*s*. 6*d*.) was issued in 1905, and a slight correction of it, as regards the zones of the chalk north of Henley, is given, on a somewhat reduced scale, in the memoir. The country depicted includes the well-known road that climbs from Henley to the woods of Nettlebed, and drops again over the face of the Chalk to the Thames alluvium at Benson. From Dorchester, one of the pleasantest of Oxford villages, we look back at the fine Chiltern scarp, through which the Thames cuts deeply. A map like this, with the section at its foot, explains a delightfully varied piece of country. The memoir hardly directs sufficient attention to the interest of the various gravels and to the problems of pebble-distribution in connection with the present valley, but the facts can, of course, all be found in Mr. White's chapters on the superficial deposits, where numerous references to other works are given. Mr. White shows how subaërial wasting (p. 79) has been going on here since Oligocene times, so that the pebble gravel of the Chiltern slope can have no definite age assigned to it. He regards the exotic pebbles, such as those of quartzite, that occur in the "plateau gravel" (p. 85), as derived from the older "pebble gravel," and as "carried into the region of the Upper Thames basin long before the commencement of the Pleistocene 'Ice Age.'"

That energetic writer, Mr. A. J. Jukes-Browne, has also prepared the memoir on "The Country around Andover" (price 1*s*. 6*d*.), accompanying Sheet 283. The map (also price 1*s*. 6*d*.) was issued in 1905. In this area we are on the great undulating plateau of chalk, over which men still travel fast—often far too fast—on the way from Basingstoke to Bath. The beautiful little valley of Kingsclere adds variety in the north-east, where a breached anticline exposes Selbornian Upper Greensand. This fold is illustrated by a section on the map itself. The uninitiated, however, must remember that the exaggeration of the vertical scale, harmless enough in the right-hand portion, produces an unfortunate effect where the dip changes rapidly on the left, the Chalk appearing as if compressed to one-third of its thickness at the outcrop. The memoir deals with the Cretaceous zones in a manner that was impossible when the area was first surveyed in 1857. In conclusion, it touches on springs and water-supply, questions of special importance in such a region.

A fourth memoir, on "The Country between Newark and Nottingham," by Messrs. Lamplugh, Gibson, Sherlock, and Wright (price 2*s*. 3*d*.), describes Sheet 126, published in 1908. There is very little glacial drift in this part of the Trent valley, and the surface is mainly occupied by Triassic strata. The chief point of interest for the dwellers in this agricultural country lies in the fact that the Coal-measures, which crop out west of Nottingham, probably underlie the whole of it. Indications of concealed faults, known already from subterranean workings, are shown by orange lines upon the map. The longitudinal section below it is properly non-committal as to the concealed coalfield; but the Clifton Colliery has already burrowed under the Trent, and the whole land eastward may yet become a "black country," with the Trent as its convenient waterway. The soils of the district are interestingly referred to on pp. 96–7.

In the Proceedings of the Geologists' Association, vol. xx. (1908), p. 390, Messrs. C. P. Chatwin and T. H. Withers describe the zones of the Chalk in the Thames valley between Goring and Shiplake, a district bearing on those recently examined by the survey. The work of these authors is, in fact, referred to in the Andover memoir. The united evidence shows that the higher zones of the Senonian were denuded away over a wide area in our Midlands before the deposition of the Eocene strata.

A special character was imparted to the later work of Mr. J. Lomas by the broad geographical outlook of the author. This is apparent in his description of the geology of the Berwyn Hills (Proc. Geol. Assoc., vol. xx., 1908, p. 477), which serves as a useful companion for any visitor to Llangollen. We may mention the account (p. 488) of the walls of the Dee valley, and their relation to former glaciers, as an example of the features here clearly brought before the reader.

In the *Jahrbuch d. k.k. geol. Reichsanstalt* for 1908, pp. 469–526, Dr. H. Reininger furnishes an interesting study of the Tertiary basin of Budweis, near the southern Bohemian border. He concludes that the plant-bearing beds were laid down in a considerable lake in Middle Miocene times between steeply falling walls of crystalline rock. The Alpine movements (p. 511) gave rise to the hollow in which the water gathered, despite the general resistance of the old Bohemian mass that surrounds the basin. Dr. Reininger points out that numerous fissures were produced in Bohemia by pressures of even later date, and that the basin of Budweis was probably uplifted with the southern Böhmerwald at some time later than the Miocene. Here we approach the edge of controversy, and once more look towards the Alps.

It is impossible to do justice, however, either in the study or the field, to the successive memoirs that appear on the tectonics of the Alps. In three numbers of *Petermann's Mitteilungen* (Bd. liv., 1908, Nos. 10, 11, and 12) Prof. Fritz Frech, of Breslau, has furnished a summary occupying forty-two pages, in which he endeavours to harmonise the views of various writers. Profs. Diener, Kilian, and Schardt have supplied descriptions of special districts, and Prof. Frech shows his fairness by a kindly reference (p. 223) to the gravitational theory of folding urged by Reyer. Emphasis is laid on the great faults that accompanied the folding in the eastern Alps (p. 256), such as the "Gailbruch," which manifested itself as late as 1346 in a terrific earthquake and a landslide, the huge scars of which can still be seen on the precipice of the Dobratsch as one leaves Villach for the south. Close at hand we find the region of the south Alpine Trias, a plateau-country cut up by vertical faulting. In his concluding sentences, Prof. Frech shows how the overfolded structure of the western Alps is connected with the dissimilar and broken structure of the east by districts, like the Brenner or the Radstädter Tauern, where both types lie near one another. This gives the Alpine chain an advantage over many other mountain regions; but the author points out (p. 282) that we may be led on from it to connect the folded ridges of Mexico with the faulted plateaus of Arizona and Utah, as manifestations of one and the same mountain-building process. The memoir is illustrated by photographic plates and sections.

Dr. Ampferer's paper on the Sonnwendgebirge, referred to by Prof. Frech in a footnote, appears in the *Jahrbuch der k.k. geologischen Reichsanstalt*, Band lviii. (1908), p. 281. Wähner has recognised certain "hornstone-breccias" intercalated among Jurassic radiolarian marls as evidences of overthrusts. Ampferer regards them as truly and evenly interbedded, and as resulting from the uplift of an eastern part of the sea-floor; the sediments already formed slipped down over the underlying slope of the Kossen beds, wrinkling themselves during this gravitational sliding. Denudation of the uplifted part by subaërial agencies set in, and the hornstone-breccias are evidences of this decay. The large blocks found in them may record actual landslips. Where the breccias are repeated, elevation and depression must have alternated. The Gosau beds were laid down unconformably on the surface due to this epoch of denudation. Features of this

kind are, of course, noticeable both in the Carboniferous Limestone and in the Chalk of our own islands. The main interest of Ampferer's paper from a tectonic point of view lies in its acceptance of Reyer's doctrine of what may be called "contemporary gliding."

In the *Verhandlungen* of the same institute (1908, p. 326) Prof. Tornquist, of Königsberg, replies to Dr. Ampferer concerning the Flysch-zone in Allgäu and the

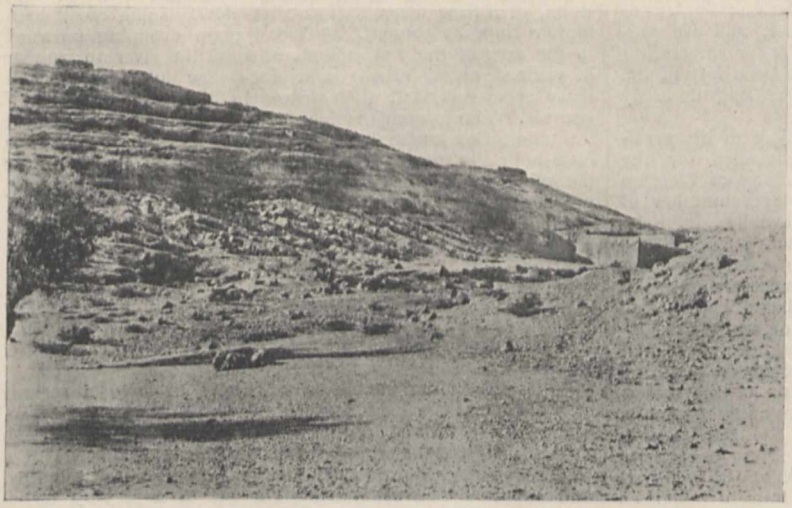

FIG. 1.—Unconformity of Sub-recent Conglomerates on Cretaceous Limestone, Kalhat, Coast of Oman, Arabia. (Photo. by A. v. Krafft.)

Vorarlberg, and he very interestingly pictures the formation of a submarine overthrust during the growth of the Flysch deposits. The Alps had even then begun to rise, and the limestone "klippe" of Allgäu was thrust over the earliest beds of Flysch and became entombed in those that were still forming. Tornquist opposes Ampferer's comparison of the phenomena with those brought about by landslides, and asks us (p. 331) to consider the effects of earth-movements on unconsolidated sediments still beneath the sea. He would like to explain, on the same principles, the "klippen" studied by Uhlig in the Carpathians. Even in the submarine processes described there seems to be a good deal that is akin to landsliding, but Tornquist makes the folding and the accompanying gliding contemporaneous with the Flysch itself.

From these closely criticised regions it is refreshing to come out with Dr. W. F. Hume into the unknown south-western desert of Egypt (*Cairo Scientific Journal*, vol. ii., 1908, pp. 279 and 314). His paper is meant for the general reader, and its style and contents would make an admirable lecture. A great southward extension of Eocene strata has been discovered by the author. His remarks on wind-erosion (p. 318) show, as one might not at first sight expect, that sand is absent where the signs of erosion are intense. The cutting agent finds no resting place, but is hurried over the edge of the desert plateau to fall in great sand-slopes towards the plain and to fill up valleys that are there sheltered from the wind.

In the Memoirs of the Geological Survey of India, vol. xxxiv., part iv. (1908), we have another of those broad surveys that are still possible in Africa and Asia, and that recall the days of von Buch, Murchison, or Darwin. Mr. G. E. Pilgrim has had the fortune to report on the geology of the Persian Gulf and the adjoining portions of Persia and Arabia. He too has felt that in science it is good to be a king,

And ride in triumph through Persepolis.

Mr. Pilgrim provides photographic views of barren landscapes, and a geological map, in which are correlated his own observations and those of his predecessors. Marine beds occur up to the Messinian and Pontian stage, *i.e.* into what are generally regarded as Pliocene times (p. 25), and the Persian Gulf is attributed to denudation acting still later on a mass that became upraised in some places 9000 feet above the sea. Then came a Pleistocene submergence, followed by still more recent elevation, of which we have evidence in the modern shore-lines.

Mr. H. G. Ferguson describes the small Batanes Islands, the northern outliers of the Philippine group towards Formosa (*Philippine Journal of Science*, vol. iii., 1908, p. 1). The basal rock is a pre-Miocene volcanic agglomerate, and the islands are thus really volcanic piles. Miocene limestones were formed across them, and became uplifted to 275 metres above the present sea. The frequent earthquakes are correlated (pp. 14 and 24) with a fault that is possibly traceable into Luzon. Volcanic activity continued in the group during the time of uplift, and Mount Iraya, in the north of Batan, has quite a modern aspect.

That excellent observer, Mr. A. J. C. Molyneux, of Bulawayo, describes part of the Bechuanaland Protectorate in the Proceedings of the Rhodesia Scientific Association, vol. vi. (1906), p. 73. This district links itself interestingly with that reported on by the Survey of Cape Colony near Kimberley, and the author traces its Waterberg and Karroo strata also north into Rhodesia (p. 86). But should he write both "Karroo" and "Karoo" on successive pages? The basalts of the Victoria Falls area are correlated with the Tuli lavas of Bechuanaland and with the volcanic rocks of Stormberg age farther south.

FIG. 2.—Extinct Volcano of Mount Iraya, in Batan Island, Philippines. (Photo. by Worcester.)

Passing to America, Mr. E. Otis Hovey has described for the first time the general geology of the western Sierra Madre in the State of Chihuahua, Mexico (Bull. Amer. Museum Nat. Hist., vol. xxiii., 1907, p. 401). The region is likely to be developed from a mining point of view, but is mainly given over to stock-raising. It

owes its relief to denudation, acting on a plateau of Cretaceous limestone and andesite, on which lava-flows of basalt and rhyolite, with additional andesite, have broken out. Important post-Cretaceous intrusions of granite occur. The broad, enclosed basins of the plateau, which are well illustrated, became filled up by débris, largely wind-borne, and sandstones and conglomerates arose which almost obliterated the original relief. The present tendency is still towards the filling of such basins by the crumbling of outstanding relics of the older surface under the action of an arid type of denudation; but rivers have cut modern cañons through the mass, and are producing a new series of relief-features. It is interesting to note (p. 422) that hanging valleys have been left in the cañon of the Aros "by the more rapid cutting done by the great stream."

Mr. A. Gibb Maitland chose as the subject of his presidential address to the Australasian Association for the Advancement of Science in 1907 "The Geology of Western Australia." This address forms a convenient summary of recent work, now that it has been published by Mr. Bristow, Government printer in Adelaide. Attention is directed (p. 10) to the attractions offered by the Cambrian beds of the Kimberley district, from which Hardman gathered an unlocalised Olenellus in 1883. The glacial boulder-bed east of the Kennedy Range (p. 16) is of early Carboniferous age. Laterite, in part pisolitic, occurs throughout Western Australia (p. 24), and is recognised as resulting from the decomposition and re-consolidation of the underlying rocks *in situ*. These rocks are commonly granites. Secondary silica converts some types of the laterite into quartzites; others pass over into bauxite. Here once more we are in face of the most interesting problem of weathering presented to us in the tropics. The laterite has been cut through by denuding agents, and some of it may be of early Cainozoic age, while in other places it is still forming.

Among papers dealing with special systems rather than with regional geology we may note one by Messrs. W. G. Miller and C. W. Knight on the Grenville Hastings unconformity (Sixteenth Report, Bureau of Mines, Canada, 1907, p. 221), in which it is urged that the Hastings series in Ontario and Quebec has an independent position, being unconformable to the underlying Grenville series, and not merely an altered portion of that series. The Laurentian gneiss is intrusive in the Keewatin series and in the overlying Grenville series in south-eastern Ontario. The Hastings series is styled Huronian by the authors.

Sir T. H. Holland (Records Geol. Surv. India, vol. xxxvii., 1908, p. 129) shows that the Blaini formation of Simla, in which he now finds well-striated boulders, need no longer be correlated with the Talchir beds, but may be much older, since glacial conglomerates are known from various horizons. The unfossiliferous sediments below it, hitherto regarded as Permian or older, may be actually as old as the pre-Cambrian, and may be classed with the author's Purana beds of the peninsular area.

In the same Records, vol. xxxvi. (1907), p. 23, Mr. H. H. Hayden discusses the age of the Gangamopteris beds of Kashmir, and furnishes good photographs of their occurrence in the field. These beds are "not younger than upper Carboniferous," since equivalents of the Fenestella-shales of Spiti overlie them.

A very interesting paper on desert conditions and the origin of the British Trias was contributed by the late Mr. J. Lomas to vol. x. of the Proceedings of the Liverpool Geological Society (1907), p. 172. Personal observations in Africa were utilised, and the author lost his life, as already recorded in NATURE (vol. lxxix., p. 226), while extending his researches in an area from which he hoped to gather much. Prof. Bonney, who has so long studied the Triassic pebble-beds, has commented on Mr. Lomas's conclusions in the *Geological Magazine* for 1908. Our knowledge of the marine Trias of Europe is increased by Dr. F. v. Kerner, who publishes a considerable paper on the southern border of the Svilaja planina in Dalmatia (*Verhandl. d. k.k. geol. Reichsanstalt*, 1908, pp. 259–289). In the uppermost zone there are reefs formed by calcareous algæ, with intervals of ordinary sediments between them, where detritus from earlier volcanic rocks was washed in among the limestone-building organisms.

Coming to much more recent times, Herr B. Stürtz, of Bonn, has made a detailed study of the "Rheindiluvium" from Bingerbruck, near Mainz, downwards to the Netherlands (*Verhandl. d. naturhist. Vereins der preuss. Rheinlande u. Westfalens* for 1907, published 1908, pp. 1–91). He does not seem to take into consideration the older extension of the alluvium of the Rhine to the English coast, which many authors have looked on as a feature of late Pliocene times. He regards the old delta as beginning near the Ahr, midway between Coblenz and Bonn, at a time when the stream-bed was some 150 metres higher than at present. A broad plain dropping seaward to the area of the Netherlands allowed the river to wander in various arms, much as it does now in Holland, and these arms have left their traces in high-level "diluvial" gravels. The present valleys of the main stream and of its tributaries must have been deepened by 100 to 200 metres in Pleistocene and recent times. The effects of the damming up of the waters by the Scandinavian ice-front are discussed. The higher deposits of löss are, however, attributed to wind-action, while others were laid down in a glacial lake between the uplands and the ice.

G. A. J. C.

A REMARKABLE DEVELOPMENT IN X-RAY APPARATUS.

THE old induction-coil seems likely to have a serious rival in the new apparatus which Messrs. Newton and Co., of Fleet Street, are showing. This is the "Snook" Röntgen apparatus. The machine consists of a motor converter driven from the continuous current mains, and supplying an alternating current to a step-up transformer. This transformer is immersed bodily in a galvanised iron tank filled with an insulating oil, the whole being hermetically sealed. The voltage at the secondary terminals of this transformer amounts to as much as 70,000–100,000, and can be regulated as required by means of an adjustable resistance in the primary circuit.

The most important adjunct is a mechanical rectifier, consisting of a rotating commutator of special design carried on the axle of the motor converter; thus it cannot get out of step, and, what is perhaps of as great importance, it requires no attention. The commutator when once adjusted in proper phase produces a very nearly unidirectional current, although, of course, perfection in this respect is unattainable, as will be realised when it is remembered that the current from the converter cannot be a simple harmonic one. Be this as it may, the rectification is very successfully made, and the simplicity of the device commends it when compared with the very troublesome valve tubes which must so frequently be employed for heavy X-ray work.

With regard to the efficiency, a current of 25 amperes at 200 volts in the primary circuit yields 60 milliamperes or more through an X-ray tube of 3 or 4 inches spark. Having inspected the apparatus while in action, we may state that we consider it to be a most efficient addition to the numerous arrangements available to the present-day worker in X-rays.

RECENT PAPERS ON MARINE ANIMALS.

AMONG papers on various groups of marine animals in serial and other publications which have recently reached us, reference may first be made to a fasciculus of "Illustrations of the Zoology of the Indian Survey Ship *Investigator*," containing plates devoted to new and other species of fishes, entomostracous crustaceans, and molluscs. In addition to certain deep-sea forms, the fishes include two species of skate, described by Dr. R. E. Lloyd in 1906, several kinds of stalked barnacles are figured, and the molluscs include seven species, described by Mr. E. A. Smith in the year already mentioned, of which the shells are for the first time depicted.

Reverting to fishes, we find Messrs. Gilchrist and Wardlaw Thompson contributing to the second part of vol. vi. of the Annals of the South African Museum one paper on the local Blenniidæ and another on various species from the Natal coast. The blennies have hitherto been very

imperfectly known, in spite of their comparative abundance, and some of the species are extremely difficult to identify. Out of a total of thirty-eight South African representatives of the family, no less than twenty-two belong to the genus Clinus, of which twelve are described by the authors as new. In the second paper a very large number of species belonging to sundry genera and families are named and described; one of these—referable to Chrysophrys—is locally known as the "Englishman," and the authors have accordingly named it *Ch. anglicus*, which scarcely seems a satisfactory designation for a South African species.

To the issue of the Proceedings of the Academy of Natural Sciences of Philadelphia for December, 1908, Mr. H. W. Fowler contributes a paper on the Pennsylvanian fresh-water fishes of the family Cyprinidæ, in the course of which a new species of Notropis is described. Owing to pollution of the streams, some species of these fishes are in danger of extermination.

Much has of late years been written on the development and life-history of the eel, a further addition to the subject being a paper, illustrated with figures and a map, by Mr. Knut Dahl, which appears in the January number of *Naturen*.

From fishes we pass to whales, the Arctic fishery for which during the past season receives a brief notice by Mr. T. Southwell in the *Zoologist* for January. Six vessels were dispatched for whaling purposes in 1908, two of which visited the Greenland seas, while three proceeded to Davis Strait and one to Hudson Bay. The Greenland fishery proved the most productive, yielding ten out of the fifteen right-whales constituting the season's catch. In addition to these, the season's expedition yielded 540 white whales, 899 walruses, 3084 seals, and 241 bears. With whalebone at about 2000*l*. per ton, the total value of the produce (inclusive of a cargo brought from Pond's Bay station by the *Eclipse*) may be estimated at between 29,000*l*. and 30,000*l*.

Turning to invertebrates, the first paper for notice is one by Dr. J. Stafford, of Montreal, published in the January issue of the *American Naturalist*, on the larva and spat of the Canadian oyster. The fact that American oysters are unisexual renders possible artificial fertilisation of the eggs and rearing of the larvæ, and these young stages have been long familiar to the naturalist, but there was a big gap in our knowledge between these stages and the fixed condition. Accordingly, the author set himself the difficult task of learning to identify oyster-fry amid the hundred forms of life to be met with in the pelagic plankton. In this he was eventually successful, having observed what he took to be the larvæ settle themselves on glass plates and develop into undoubted oyster-spat. Further study of the plankton will probably enable the height of the breeding-season to be definitely determined. At present it seems that oyster-larvæ occur in the water from July 11 to September 1, and that spat make their appearance from August 16, thus suggesting that during the second half of August there occur the last stages of growth of late larvæ, and that the period of growth of the masses dates from between July 11 and August 16. The eggs are therefore probably deposited about the first of July. The paper concludes with a summary of the results of the author's investigations, and also contains remarks upon the important bearing of these and earlier observations on the problems and methods of artificial oyster-culture.

The last two papers for notice are by Dr. Gilchrist, the one, in the above-mentioned issue of the Annals of the South African Museum, on two new species of Ptychodera, and the other, in vol. xvii., part ii., of the Transactions of the South African Philosophical Society, on new forms of Hemichordata from South Africa. In the former paper Dr. Gilchrist observes that, in addition to the undermentioned *Ptychodera capensis*, another representative of the same genus is found in the same localities in fair abundance under stones, but usually somewhat nearer to high-water mark. Among the adult forms were found a number of smaller ones, in which the proboscis and collar were in all stages of development, this apparently indicating a process of natural fragmentation or proliferation from the tail end of this species, for which the name *Pt. proliferans* was accordingly suggested. The second, *Pt. natalensis*, is from the Natal coast, and is characterised, among other features, by the extremely short proboscis. *Pt. capensis* is described in the second paper.

In the latter paper it is mentioned that the three orders of the Enteropneusta are now known to be represented in South African waters, the Enteropneusta by the above-mentioned species of Ptychodera, the Pterobranchia by a species of Cephalodiscus, and the Phoronidea by a new species of the type-genus (*Phoronis capensis*), and by the new genus and species *Phoronopsis albomaculata*. The last-named, which is figured in its fully expanded form alongside *Phoronis capensis*, is an exceedingly beautiful organism, differing from the type-genus mainly in having an involution of the epidermis with definitely differentiated (cubical) cells. The involution occurs below the nerve-ring, which it partially covers, and passes round the body so as to encircle the mouth, vent, and nephrideal apertures.

MEANING AND METHOD OF SCIENTIFIC RESEARCH.[1]

IN this day of encyclopædias numerous and ponderous, one is often struck with the fact that in spite of the manifest care and conscientious thought bestowed by the responsible editors, the omissions and evidences of discontinuity of treatment, and lack of recognition of the prime purposes of the compilation, are as noteworthy as the imposing array of the results of our steadily advancing knowledge is startling. For a philosophic treatment—one fully appreciative of that which the student really requires, not only to enlighten him with regard to a particular subject, but also to stimulate him to research where it is most needed—I frequently get more satisfaction out of the older encyclopædias than from our modern ones, even though they can but present the status of the subject up to the time they were written.

As an illustration, take the word "research," or any of the associated terms—"discovery," "experiment," "investigation," and "observation." Turning to the index volumes of the ninth and tenth editions of the "Encyclopædia Britannica," I find but two references in which the word "research" appears—one to the exploring vessel, the *Research*, and the other to "research degrees." Turning to the page on which the latter occurs, we find this interesting statement referring to Oxford University:—

"New degrees for the encouragement of research, the B.Lit. and B.Sc. (founded in 1895, and completed in 1900 by the institution of research doctorates), have attracted graduates from the universities of other countries. In 1899 a geographical department was opened, which is jointly supported by the University and by the Royal Geographical Society." Now comes the interesting statement which I beg to emphasise:—"*Of more bearing on practical life are the Day Training College Delegacy* (1892) *and the diploma in education* (1896). *Under the former elementary school teachers are enabled to take their training course at Oxford, and do so in growing numbers*," &c.

We thus see what the writer of this article thinks of the relative value in practical life of research foundations and normal school foundations! Sir Norman Lockyer, in his luminous inaugural address before the British Association for the Advancement of Science in 1903, on the "Influence of Brain-power on History," says:—"A country's research is as important in the long run as its battleships." Why, then, does not the standard encyclopædia of that country make space for a representative article on "research"?

Under "investigation" there also appears absolutely nothing. However, we have the *Investigator* ship, Investigator Shoal, Investigator Group, &c., but not a word about the general methods employed by "scientific investigators"; and so it is with the word "discovery"—there is no reference whatsoever to an article on the

[1] Abridged from an address by Dr. L. A. Bauer as retiring president the Philosophical Society of Washington, delivered before the Society on December 5, 1908.

general principles leading up to discoveries. Likewise with the word "observation." Though there are many references to observations of various kinds, there is no one article for setting forth the general principles of "observations" or the part they play in the discovery of fundamental facts. The same experience is had with regard to the word "experiment."

Now let us turn to an encyclopædia I invariably read with pleasure and profit; it frequently has supplied me with references to earlier work not to be obtained elsewhere. We shall find it instructive, though the articles to which I beg to invite your kind attention were written three-fourths of a century ago. I refer to the classic Gehler's "Physikalisches Wörterbuch"—the revised edition by the noted investigators Brandes, Gmelin, Horner, Littrow, Muncke, and Pfaff, in twenty volumes, and published in Leipzig, 1825–45. A veritable fund of information is found under the headings "Beobachtung" (observation) and "Versuch" (experiment). The article on "Beobachtung," by the physicist Muncke, embraces twenty-eight octavo pages. He shows the distinction between "Beobachtungen" (observations) and "Versuche" (experiments) to be that the former pertain to the perceptions of phenomena presented to us by nature in her unmodified course, whereas in the latter—in the experiments—we are seeking to produce certain results or phenomena, more or less looked for, in order either to verify a law already known or to disprove one suspected of being wrong, or even to discover a new one. Both classes of experiences are necessary for a piece of investigation or research work.

Thus we may behold, either visually or in some other way, certain striking solar phenomena; these belong to the class of observations which we ourselves are unable to modify in any manner whatsoever. Continued observation may, however, reveal a certain law which by experiment in the laboratory, conducted along more or less definite lines, we may seek to imitate in the hope of getting some clue to the *modus operandi* of the observed phenomena. In this article on "observations" the author treats in detail the various elements entering into correct methods of investigation, condition of the observer and of his senses, his being unbiased, character and errors of the instruments, errors of results, methods of increasing accuracy, representations of observations by graphs and formulæ, method of least squares, &c. He points out the mistake sometimes made that an established formula satisfying the observed phenomenon within certain limits represents an actual law of nature.

The article "Versuch" (experiment) consists of forty-four pages, and is contributed by the astronomer Littrow. He shows that the most rapid development takes place in those sciences which afford the greatest opportunity for experimentation, referring, *e.g.*, to the slow and painful progress of the astronomer so long as he had to confine himself to mere celestial observations, and the comparatively rapid strides which occurred so soon as some of the observed phenomena could be either imitated by, or be compared with, those derived by laboratory experiment. The investigator, he says, must be absolutely free from preconceptions, and be careful, cautious, and unbiased in his interpretation of what his senses may reveal to him. He illustrates how man, called jokingly "das Ursachenthier" (the animal ever bent on ascertaining the cause of things), proceeds in ferreting out the why and wherefore of observed phenomena, and how his methods of circumspection develop with the advance of knowledge.

Though man cannot determine the "Endursachen," or ultimate causes of things, the field open to him to discover the laws governing phenomena or *vice versâ*, classifying and enumerating those which follow a certain revealed law, is, nevertheless, still very large and sufficient to tax his energies. Witness, for example, the host of observed phenomena obeying the law of inverse squares!

These two articles will show sufficiently the character and scope of similar ones we should like to see in our standard English and American encyclopædias.[1] Such information is contained in some measure, at least, though not as comprehensively, in the modern German book of reference, Brockhaus's "Conversations-Lexikon," as also in the "Grande Encyclopédie" of the French.

Our foremost English dictionaries are in general not any more satisfying or edifying regarding the precise meaning of "research" in the scientific sense than are the standard encyclopædias. Their illustrations of the use of the word are usually neither apt nor sufficiently comprehensive.

A good-sized chapter might be written on the "mathematical instruments or tools of research." The predominating tendency of resolving or expressing every natural phenomenon—periodic or otherwise—by a Bessel or a Fourier series or by spherical harmonic functions has brought about at times, especially in geophysical and cosmical phenomena, if not direct misapplications, at least misinterpretations of the meaning and value of the coefficients derived.

Frequently by the purely mathematical process there have been eliminated, in the attempt to represent a more or less irregularly occurring natural phenomenon by a smoothly flowing function, the very things of chief and permanent interest. The normal or average diurnal temperature curve, for example, or a uniform magnetic distribution over land, so as to yield perfectly regular lines of equal magnetic declination, never occur in nature. There is thus being impressed upon us more and more forcibly the fact that what we have been regarding as "abnormal features"—the outstanding residuals between observations and the results derived from the mathematical formula—are in truth not "abnormal" from the standpoint of nature, but are rather to be taken as indicative of the "abnormality" or "narrow-mindedness," which means the same thing, of ourselves in trying to dictate to nature the artificial and regular channels she should pursue in her operations.

Louis Agassiz said:—

"The temptation to impose one's own ideas upon Nature, to explain her mysteries by brilliant theories rather than by patient study of the facts as we find them, still leads us away."

The fundamental law of nature is to follow invariably the paths of least resistance, and by examining these lines of structural weakness of the opposing systems we may have opened to us the very facts which are to be of real value and of sure benefit to mankind. The irregularity of the banks bordering a natural watercourse serves to differentiate the work of nature from that of the builder of the artificial and regular channel.

No, instead of rejecting, we must learn to retain the outstanding residuals and study them most carefully and regard *them* as the true facts of nature, and not those which we so egotistically and presumptuously try to force on her. What great discoveries may lie open to us when we once have grasped the true significance of the facts we have been so fond of measuring by our own standard and have been terming as "abnormal" or "irregular"!

An interesting example of not wholly successful application of the continuous and ever-recurring functions of spherical harmonics to a typical geophysical phenomenon—the distribution of magnetism over the earth's surface—has been discussed by me elsewhere. Though the number of unknowns has been increased in recent computations from the original twenty-four of Gauss to forty-eight, nevertheless the difference between theory and observation is of such an order of magnitude as to preclude the use of the formula for even the purely practical demands of the navigator and surveyor. Nor has anyone succeeded in giving any physical interpretation of the laboriously derived coefficients beyond the first three. And what do these three stand for? The simplest possible case of a first approximation to the actual state of the earth's magnetism, viz. that of a uniform magnetisation about a diameter inclined to the axis of rotation!

The prime difficulty here may be summed up in a word. The very surface over which the spherical harmonic functions are spread is itself such a prolific source of disturbance as to cause effects embracing a continent, a State, or a locality. Such a large number of terms would be requisite for an adequate representation as to make their

[1] Chambers's Encyclopædia is found to contain a short article on "Experiment"; also one on "Observation."

computation prohibitive. We are dealing here with more or less discontinuous effects that cannot be imitated by continuous functions without leaving behind a train of residuals, precisely as though we were to try to fit to the actual configuration of the earth some standard pattern of our own. Let me ask what phenomenon have we, in fact, which will admit of the determination of forty-eight, or even of twenty-four, physical constants?

It had been my intention to say a few words on the value and limitation of that much-used as well as abused mathematical instrument of research, the method of least squares. Properly employed, it is a most useful adjunct to investigation; but, as intimated, the true significance of formulæ established by this method is at times pushed way beyond the limitations. What the tenor of my remarks might be will be sufficiently evident to you if I submit this query for your consideration, What actual laws of nature have been discovered by the method of least squares?

It is an extremely interesting and suggestive fact that the greatest experimental discoveries to-day are not made in the older, well-recognised sciences, but on their borderlands—in the "twilight zone" of more or less related sciences. I have but to mention the words "physical chemistry," "physical geology," "astrophysics," "biochemistry," &c., and you will readily grant the assertion made. In the overlapping regions there seem to be the greatest opportunities afforded for solid, thorough, and at the same time remarkably rapid, experimental achievements; and so we are having produced almost daily new specialities or new subspecialities.

What is the effect on the general broad-mindedness of man of this extreme specialisation, so necessary for the production of the best and most far-reaching results? *Is the modern specialist more narrow-minded than the generalist of a century or two ago?* In view of the fact that the prime instrument of research is, after all, the mind, the question is not an irrelevant one. We find statements occasionally made which would imply an affirmative answer to our question; but I, for one, would most emphatically protest against such an inference. I should maintain that the specialist, other things being equal, is likely to be a broader man than he who has no speciality, but simply a general knowledge of some particular science. The reason for my positive statement would be found in the fact mentioned, that the greatest part of the research work to-day is being done on the border-lands of the general sciences, for he who wishes to take part in this very active competition must needs be far better equipped than the mere generalist. The physical chemist, to be most successful, must have a very intimate knowledge of both physics and chemistry, and the more mathematical skill he possesses the better. The astrophysicist must be a physicist, a chemist, a mathematician, besides being an astronomer. And so with regard to the geophysicist.

Only a few names need be cited—like those, for example, of Faraday, Maxwell, Kelvin, von Helmholtz, Mascart—to support the contention that the broadest physicists are, as a rule, those who have regarded their laboratory experiments and deductions therefrom merely as a means to an end, not an end in themselves, and who have accordingly sought to apply the knowledge gained to the solution of some of the great problems affecting the general welfare of man. There is the greatest need in America of well-trained and well-equipped physicists in the solution of the many perplexing problems of the earth's physics with regard to the phenomena of seismology, vulcanology, meteorology, atmospheric electricity, terrestrial magnetism, &c. When the investigator makes the attempt to apply some of his laboratory facts to geophysical and cosmical phenomena, he has opened to himself a world of which he never dreamed; he finds zest in familiarising himself with the fundamental facts of other sciences in which until now he could take no interest.

It is always interesting to know what was the precise course followed in the discovery of a great law. However, no two investigators have ever pursued, or at least but rarely, precisely the same paths, and we must therefore be content with the statement of the general principles of research such as has already been given.

A prevalent fault is observed in scientific publications whenever the investigator has had good training only on the observational side, and but very little experience in scientific computing. He is very apt to violate one of the first and fundamental principles of good observing, viz. to employ such a method or scheme of observing as will yield but one definite result, and that with the highest possible accuracy and with the least amount of computation. Oftener than may be thought, schemes of observation are used which leave an arbitrary element to the computer, and in consequence a different result is forthcoming, according to who makes the computation. Had we time, apt illustrations could readily be given from published works. The point made, that the observer must also bear in mind the computation side, and work up his results as soon as possible, is of fundamental importance in research work.

It may be worth while to consider briefly the insatiable desire of the analyst to ring in a series of sines and cosines to resemble the course of some natural phenomenon of which he does not know the exact law. Is this the old story over again, though in somewhat altered garb, of the epicycles and deferents of ancient astronomical mechanics, which received its highest development in the Ptolemaic system of the universe? You will recall that Ptolemy, building on the suggestions of Apollonius and of Hipparchus, supposed a planet to describe an epicycle by a uniform revolution in a circle the centre of which was carried uniformly in an eccentric round the earth. By suitable assumptions as to his variable factors he was thus able to represent with considerable accuracy the apparent motions of the planets and to reproduce quite satisfactorily other astronomical facts. This was the artifice employed by the astronomer of the period before the modern and more subtle art of simulating nature, by the sine-cosine method, had become known.

What seemed so intricate and complex in Ptolemy's time could be expressed in very simple language indeed, when a Kepler discovered the true functions as embodied in his three fundamental laws. The present method of hiding our ignorance of the real law seems at times to exert such a mesmerising influence as to make us mistake the fictitious for the real.

Of course I do not mean to discard this useful and, in fact, indispensable tool of research, but simply wish to direct attention to its limitations and to the importance of not overlooking the fertile by-products, the residuals, which, because of our neglect of them, may some day rise and smite us in their wrath. Each one of us at one time or another has doubtless established, by least squares, an empirical formula of some kind which so beautifully fits the observations as to make us bold and venturesome. Now comes a new observation, somewhat outside of the range for which the expression was established. Eagerly the test is applied, and we find to our chagrin that the formula on which so much work had been spent will not fit the new result, and that we have a "counterfeit" and not the real law.

Let us suppose, for illustration, we are dealing with a phenomenon which almost entirely unfolds itself during the time between sunrise and sunset—the well-known diurnal variation of the earth's magnetism is a striking case of the kind. Following the usual method, the phenomenon is resolved into component parts with the aid of a Fourier series. The formula as generally adopted includes the four terms having, respectively, periodicities of 24, 12, 8, and 6 hours. For ordinary magnetic latitudes the striking result is obtained that the second term—the 12-hour one—is as important as the first, or 24-hour, one; so we might equally as well say "the semi-diurnal" as "the diurnal variation of the earth's magnetism." In fact, as the semi-diurnal term unfolds itself twice in twenty-four hours, it is in reality more important than the purely diurnal one.

Does the resolution into Fourier terms of a phenomenon of the kind given really prove their existence in nature? Can we conclude, without question, *e.g.*, that in addition to the diurnal term we also have a semi-diurnal one? Even with four terms the series does not represent each hourly observation of the twenty-four with the same degree of precision. In fact, the residuals for the night hours are nearly of the same order of magnitude as the observed quantities. If the physical existence of the 12-hour term

is not proved, then there is no need of racking our brains as to its physical origin.

The difficulty disclosed by this example is of the same kind as the one treated in spherical harmonics, viz. that we are attempting to represent a discontinuous function having a duration commensurate with that of the daylight hours by functions running smoothly through their individual courses for twenty-four hours.

I cannot close this section better than by quoting the following passage from the address of the first president of this society, Joseph Henry, given on November 24, 1877:—

"The general mental qualification necessary for scientific advancement is that which is usually denominated 'common sense,' though, added to this, imagination, induction, and trained logic, either of common language or of mathematics, are important adjuncts. Nor are the objects of scientific culture difficult of attainment. It has been truly said that the 'seeds of great discoveries are constantly floating around us, but they only take root in minds well prepared to receive them.'"

Henry's insistence on the application in our scientific work of "common sense" reminds one of Clifford's apt definition of science as being "organised common sense."

It may be taken as almost axiomatic that whatever is worthy of investigation should be made known in some effective manner, so as to reach without question those concerned. The multiplicity of literature on any one subject, or even on any small portion thereof, is nowadays such that the worker finds it utterly impossible to keep abreast of publications, even those in his own field, to say nothing of kindred ones.

He is forced more and more to rely on abstracts—at least in so far as to direct him to that which he unquestionably must consult in the original, if possible. As the investigator usually finds it necessary to consult the original publications, the next conclusion to be drawn is that the publication of any research work should, in general, be of such form and size as to permit the widest distribution possible, not only among the libraries and the principal seats of learning, but also among the workers and institutions immediately interested.

The scientific worker generally does not possess the means to purchase or to construct the instruments he requires for the prosecution of his work, and a book bearing in any way on the line of work to be pursued is as much to be considered part of his equipment as the purely mechanical tools. Indeed, I was told by the late von Bezold that Wilhelm Weber set his laboratory students to work by telling them, "Here are the instruments, and there are the *Annalen der Physik*; now go to work." The man of science usually wants his tools close by and within ready reach. He cannot afford to go to a distant library and then possibly find the book out. Private possession permits him, furthermore, to make marginal notes and references to enable him quickly to put his finger on the very thing needed.

Owing to these well-recognised needs, there has grown up a courteous and friendly interchange of publications among co-workers and sympathisers in the same field that to my mind deserves the highest encouragement. The time has unfortunately gone when scientific investigators can write such delightful and voluminous letters as passed between the research workers of half a century and more ago. The present system of interchange of publications has necessarily taken the place, to a very large extent, of the early letter-writing.

It is as important to make research work known as to do it. To get our friends to read the contributions we may make to science requires nowadays no little skill and diplomacy and an attractiveness of literary style on the part of the author not so essential in the days of less frequent printed works. The original purposes of important and costly expeditions are sometimes well-nigh defeated or superseded, because of the delay in publication, ensuing from the elaborateness of the plan adopted for the reduction of the field results and the form of publication decided upon. Reduction in the pretentiousness, size, and cost of scientific publications appears to me to be one of the greatest needs of research to-day.

Some time could profitably be spent on a consideration of the general agencies engaged in furthering research work and the methods employed for doing so. Being connected with a "research institution," I should consider myself incompetent to enter upon a free and unbiased discussion of the methods of such organisations for the furthering of research work. I will, however, take as an example the general magnetic survey of the earth as representative of the kind of world-embracing research enterprises I have in mind.

Alexander von Humboldt, whose mental grasp was extraordinary in more than one science, set forth the following plan in his "Cosmos" for a general magnetic survey of the globe.[1]

"Four times in every century an expedition of three ships should be sent out to examine as nearly as possible at the same time the state of the magnetism of the earth, so far as it can be investigated in those parts which are covered by the ocean. . . . Land expeditions should be combined with these voyages." . . .

"May the year 1850 be marked as the first normal epoch in which the materials for a magnetic chart shall be collected, and may permanent scientific institutions (academies) impose upon themselves the practice of reminding, every twenty-five or thirty years, Governments, favourable to the advance of navigation, of the importance of an undertaking whose great cosmical importance depends on its long-continued repetition."

Here was a noble project, universally conceded to be not only of the greatest scientific interest, but also of the greatest practical importance. Yet why is it that this grand plan has never been carried out by the foremost nations in friendly concert? Have our academies, as Humboldt suggested, never "imposed upon themselves the practice of reminding every twenty-five or thirty years Governments, favourable to the advance of navigation, of the importance of an undertaking" of this character?

Instead of working along a common and definite plan, the magnetic operations hitherto have consisted of more or less isolated and incomplete surveys, independently undertaken by various nations and distributed over a great number of years. Not even for a single epoch has it been possible to construct the magnetic charts on the basis of homogeneous material, distributed over the greater part of the earth, with some attempt, at least, at uniformity. As to the possibility of constructing the charts, with the aid of similar data, for epochs twenty-five to thirty years apart, as Humboldt had dreamed, this, in spite of the enlightened interest of many countries, is even more remote.

Why should it have remained for a purely *research* organisation to undertake a problem touching so keenly as this on even the so-called sordid, purely practical interests of man? Is it a fortunate fact that Humboldt's fascinating international scheme failed of execution, and that the chief brunt of the work is now being borne by a single organisation? The magnetic work of the Carnegie Institution of Washington has embraced, since 1904, a general magnetic survey of the Pacific Ocean, and land observations have been made in more or less unexplored regions in different parts of the world. The ocean magnetic work is to be undertaken next in the Atlantic Ocean, in 1909, on a specially built vessel, the first of its kind.

It is believed that an effective scheme of operation has been evolved, with the aid of the valuable advice received from eminent investigators. Without danger of giving offence to anyone, it is possible to deal directly with the officials concerned, submitting to them our plans and ascertaining whether they contemplate doing anything similar, and, if so, whether, in case their funds are insufficient, they could suggest some friendly basis of co-operation between their organisation and ours. This plan of action has met with entire success thus far. Duplication, overlappings, and possible jealousies are all avoided; and in countries where no organisation whatever exists to do the work, we are free to go ahead and finish the task in less time than it would necessarily take to get an official action or official consensus of opinion from a large scientific body.

Slow deliberation in terrestrial magnetic work would be disastrous, for the prime reason that the phenomena of investigation in this field of research are continuously

[1] The quotation is from E. C. Otté's translation of the "Cosmos," vol. ii., pp. 719–20.

undergoing change. The time-element in the earth's magnetism, even for a period of a few years, is of such moment as completely to mask the fine, hair-splitting points which would necessarily and rightly have to be raised on some international mode of action, to say nothing of the painful and cumbersome method which would have to be employed to conform with the rules of official correspondence between nations. Many a well and carefully executed magnetic survey in the past has had its full importance for world-wide investigation destroyed because of the possibility of error in the secular variation corrections which must be applied to bring its results up to the date of the later data.

The course pursued by the Carnegie Institution of Washington in conducting the general magnetic survey of the globe is the only way in which this particular project, and similar ones to it, could not only be expeditiously conducted, but also realise the chief objects of the work. This policy, briefly stated, is to make, with the aid of the friendly and harmonious cooperation of all concerned, a rapidly executed magnetic survey of the greater part of the globe, so that a general survey, all-sufficient for the solution of some of the great and world-wide problems of the earth's magnetism, will be completed within a period of ten to fifteen years. At a smaller number of points, selected in consideration of the prime questions at issue, the observations are to be repeated at intervals of five years or less, in order to supplement the rather sparsely distributed magnetic observatory data. Thus the determination of the corrections for reduction of the general work to any specific date is continuously provided for.

The most evident result of all magnetic work in the past is that, for the purposes of a general survey, it is far better to make some sacrifice in accuracy if thereby it is made possible to secure observations at another point. In other words, the errors due to local disturbing conditions are far greater than the purely observational ones. Hence multiplicity of stations rather than extreme accuracy and laborious methods of observation and reduction is the prime requisite.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

CAMBRIDGE.—The general board of studies has approved Prof. E. C. Stirling, F.R.S., and Prof. W. Ridgeway, Disney professor of archæology, for the degree of Doctor in Science.

The council of the Senate has appointed Prof. Biffen as a representative member of the John Innes Horticultural Institution for four years from February 8.

OXFORD.—The vacancy in the Waynflete professorship of mineralogy at Oxford has been filled by the appointment of Mr. H. L. Bowman, of New College, who for many years acted as demonstrator under Prof. H. A. Miers.

On Friday, February 12, the hundredth anniversary of the birth of Charles Darwin was celebrated at Oxford by a reception given in the examination schools by Profs. Vines, Poulton, and Bourne. The proceedings were opened by the Dean of Christ Church, acting for the Vice-Chancellor, who was unavoidably absent. In the course of an interesting address on fifty years of Darwinism, Prof. Poulton spoke of the various influences which had moulded Darwin's career, dwelling especially on his early friendship with Henslow, to whom was due what proved to be the turning point in Darwin's life—his appointment as naturalist to the *Beagle*. The support and encouragement given to Darwin by Lyell, Hooker, and Asa Gray, and the vigorous championship of Huxley, were passed in review, special mention being also made of the chivalrous conduct of Wallace in seeking to minimise his own claims as joint discoverer of the principle of natural selection. The famous contest at the meeting of the British Association at Oxford in 1860 was touched upon, and the lecturer took occasion to contrast the matured views which, after being tested during twenty years of reflection and investigation, at last found expression in the publication of the "Origin of Species," with the hasty and ill-informed impressions of Darwin's early critics. Much of the rapid success of Darwin's theory in gaining acceptance at the hands of the scientific world was due to the personality of its author, whose noble qualities of mind and character were shown alike in his dealings with opponents, with friends, and with younger workers in his own subjects. All this work was accomplished in spite of constant bodily exhaustion from ill-health, to which cause the lecturer was inclined to attribute the lack of appreciation of literature and music in later life, which Darwin himself recognised and deplored. No upheaval in the realms of human thought had carried with it more of immediate pathos and of ultimate triumph than the doctrine of organic evolution, now and always to be associated, first and foremost, with the name of Charles Darwin. Among the assembly on Friday were four of Darwin's sons, Mr. William Darwin, Sir George Darwin, Mr. Francis Darwin, and Major Leonard Darwin. Sir George and Mr. F. Darwin briefly addressed the meeting, confirming the account given by Prof. Poulton of their father's genius and character. In the course of the evening a telegram was received conveying "the greetings of Cambridge zoologists, assembled in Darwin's old rooms, to their Oxford colleagues."

DR. O. V. DARBISHIRE has resigned his lectureship in botany at the University of Manchester.

PROF. HENRY A. MIERS, F.R.S., principal of the University of London, will present prizes and certificates to students at the South-Western Polytechnic Institute, Chelsea, S.W., on March 12.

THE eleventh annual dinner of the Central Technical College Old Students' Association will be held on Saturday, February 20, at the Trocadero. Dr. H. T. Bovey, F.R.S., Rector of the Imperial College of Science and Technology, will be one of the chief guests.

BOWDOIN COLLEGE, at Brunswick, Maine, U.S., has recently received funds amounting to something more than 100,000*l*., given by a former student at the college, Mr. Joseph Edward Merrill, a business man of Boston. A few weeks before his death in January Mr. Merrill transferred a large part of his property to the college, and bequeathed practically all the rest of his estate to the same institution by his will. Bowdoin College, it may be remembered, was the alma mater of Nathaniel Hawthorne, of Henry W. Longfellow, of President Franklin Pierce, of the late Speaker Thomas B. Reed, and of the present Chief Justice of the United States, Melville W. Fuller.

A BILL has been introduced in the Wisconsin Legislature, says *Science*, which proposes to increase the building fund of the University of Wisconsin from 40,000*l*. to 60,000*l*. annually, and to lengthen the period of this appropriation from five to seven years. From the same source we learn that a new industrial fellowship has been presented to the University of Kansas by the Holophane Glass Co. It yields 300*l*. a year for two years, together with 10 per cent. of the profits that may arise from any discoveries made by the student who pursues special study. The fellowship is open to students of any university, but the work will be done in the laboratories of the University of Kansas.

A REPRESENTATIVE selection from the exhibits in the British Education Section of the Franco-British Exhibition held last year at Shepherd's Bush, London, has been on view at the Belfast Municipal Technical Institute during the past three weeks. Admission was free, and to explain the purport of the exhibition a series of explanatory addresses by educational experts was arranged. The Belfast Library and Technical Instruction Committee is to be congratulated upon securing the loan of these instructive exhibits from the various education authorities concerned, and it is satisfactory to know that the illustrative specimens, collected at the expenditure of much time and trouble by the authorities of the Franco-British Exhibition, are being placed at the disposal of the great educational institutions in our chief centres of population.

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, December 10, 1908.—"The Extension of Cracks in an Isotropic Material." By A. **Mallock**, F.R.S.

Any specified strain in a solid can be represented as a combination of shear and volume extension or compression, and both for volume extension and shear there are limits which if exceeded either cause rupture or leave the material in an altered condition when the stress is removed.

There is, however, no known limit of rupture for the volume compression of solids.[1]

It would be a matter of interest and importance to determine for solids whether, and how far, the existence of one form of strain influenced the limits of the other, whether, for instance, a body subjected to volume extension would require more or less shear to rupture it than when the volume was normal.

This point has not, so far as the author knows, been made the subject of experiment, but for the purpose of this note it is assumed that if a strain which exceeds either of the limits is applied to a solid, rupture will be due to that property of the substance for which the limit is least, and that if the distortion limit is the smaller of the two, breakage will occur at right angles to the lines of greatest extension, whereas if the volume limit is the least the direction of the break will be indeterminate.

If the conditions of strain at the end of the crack are such that material gives way from over-distortion, the fracture will occur in the plane of the existing crack, which will therefore spread continuously, while if the over-dilatation is the origin the breakage may take place in any direction. If at any place the plane of the new fracture cuts the plane of the crack there will be a re-arrangement of stresses, and a relatively considerable length of material will have to be strained before further rupture is possible, and thus the cross-fractures will act as a bar to the further extension of the crack.

It is concluded, therefore, that in materials such as glass or other substances in which cracks spread in nearly constant directions rupture is due to the distortion limit, and that where a crack extends with difficulty in a wandering manner the dilatation limit is the one which has been exceeded.

The rapid alteration of the direction in which fracture takes place may give rise to the fibrous appearance which often shows itself on broken surfaces in such cases.

When the limits for both μ and κ are reached at nearly the same time, a very small change in either, such as might occur in a body nearly, but not quite, homogeneous, would alter altogether the appearance of a fracture.

In this note only isotropic materials are considered, but it seems probable that the same principles might be used to explain the cleavage of crystals.

Challenger Society, January 27.—Sir John Murray in the chair.—Notes on the breeding habits and development of *Littorina littorea*: W. M. **Tattersall**. On changing the water in the aquarium for fresh sea-water, copulation of the periwinkles was readily induced. The eggs are deposited in small capsules shaped like a panama hat, and are not attached, which accounts for their not having been recorded hitherto. Of the four British species of Littorina, *littorea* is exposed only at low spring tides, and is freed as a trochosphere, later becoming a veliger; *obtusata* is generally exposed at ordinary low water, and is freed as a veliger; *rudis* is exposed during the greater part of the day, and is viviparous; *neritoides* lives between the high water of springs and neaps, and is also viviparous. Both in habitat and life-history these four seem to represent stages in adaptation to a land existence.—British Oithonæ: G. P. **Farran**. It was pointed out that they are four in number, and inhabit, respectively, waters of low salinity, ordinary coastal waters, oceanic waters bordering on the coastal area, and purely oceanic waters. Structural modifications accompany the increase in salinity of the different habitats.—The four species of Polycheles from the N.E. Atlantic: S. W. **Kemp**. Notes on their habits and on the structure of the vestigial eye.

Zoological Society, February 2.—Mr. F. Gillett, vice-president, in the chair.—Christmas Island: Dr. C. W. **Andrews**. Attention was directed to the differences in the fauna associated with influx of population.—Preliminary account of the life-history of the leaf-insect, *Phyllium crurifolium*, Serville: H. S. **Leigh**. The leaf-insects occur in the tropical regions of the Old World, and seem partial to insular life. The eggs, which resemble the seeds of certain plants to a remarkable degree, require to be kept in a constantly warm and moist atmosphere to enable them to hatch; they hatch very irregularly, and the period of incubation often extends over three or four months. When young the larvæ are active as compared with older individuals. The metamorphosis is incomplete, and the adult form is attained by a gradual increase in size; fully developed tegmina and wings only appear in the adult condition. The adult females are large and leaf-like in appearance, but the males are much smaller, and not foliaceous.—The mammals of Matabeleland: E. C. **Chubb**.—Pathological observations at the society's gardens during 1908: Dr. H. G. **Plimmer**.

Linnean Society, February 4.—Dr. A. Smith Woodward, F.R.S., vice-president, in the chair.—*Fucus spiralis*, Linné, or *Fucus platycarpus*, Thuret; a question of nomenclature: Dr. **Börgesen**. The purport of the paper was to show that recent statements by Prof. Sauvageau as to the validity of the name *Fucus spiralis*, Linn., are not supported by the history of the plant, nor by specimens in the Linnean herbarium.—Observations on the œconomy of the *Ichneumon manifestator*, Marsham (nec Linn.): an historical note: C. **Morley**. The writer referred to the account given in 1794 by a former secretary of the society, Thomas Marsham, of an insect observed in Hyde Park. Mr. Cockayne found recently in the same place a specimen of *Ephialtes extensor*, Tasch., a Continental species not hitherto noticed in Britain; the paper concludes by pointing out the similarity of the two occurrences, and the difficulty of clearing up the synonymy.—The Polyzoa of Madeira: Rev. Canon **Norman**. For more than forty years the late Mr. J. Yate Johnson was residing at Madeira, and diligently studied both its flora and fauna. He especially devoted himself to the marine fauna, and the Polyzoa did not escape him. From time to time he submitted the species which he found for determination by naturalists who specially worked at this class—first to Prof. Busk after his death to Rev. Thomas Hincks, and subsequently to Mr. Waters. The total number of species found by him was 52; the present paper contains 139. Previous writers on the Polyzoa of Madeira have been unable to give particulars as to the circumstances (habitat, depth, &c.) at which the various species lived. These particulars the author supplies as regards most of the species previously known as Madeiran. With respect to the additions now made, there are some species new to science; others previously known in the Mediterranean; others which have been recently described from the Prince of Monaco's dredgings, and two species the occurrence of which is certainly interesting.

Royal Anthropological Institute, February 9.—Prof. W. Ridgeway, president, in the chair.—Dene-holes: Rev. J. W. **Hayes**. It was held that these excavations were merely chalk wells or chambers from which chalk was taken for builders' mortar or for manure for the fields. The author did not contest that all the dene-holes were modern; some may well have been dug in Saxon or even in Roman times, but others were certainly not more than 100 years old, and some were dug within the last quarter of a century. Evidence was adduced to show that even at the present day the farmers in some parts of the country, Hertfordshire, for example, still get chalk for the land from similar pits. The use of chalk for building was enlarged upon, and the author was able to show that the Chislehurst caves were nothing more than an old chalk mine, the so-called altars, or steps, being merely platforms left purposely to enable the workmen to reach the roof of the cavern. The author was also able to show that where

[1] This may give an explanation of the difference between malleability and ductility. Under the hammer the strain is a shear combined with volume compression, while in "drawing" the material undergoes shear combined with volume dilatation. In general, a body which is ductile will also be malleable, but the converse need not hold.

a firm stratum of chalk, suitable for builders' lime, was found under the Thanet sand, it would pay the excavators better to make fresh shafts through the sand than to tunnel in the ordinary way and hoist the material excavated through a single shaft. The cones of sand usually found at the bottom of a dene-hole were explained as the result of the refuse of a new shaft being deliberately thrown down an old one.

Mathematical Society, February 11.—Sir W. D. Niven, president, in the chair.—The conformal transformations of a space of four dimensions and the generalisation of the Lorentz-Einstein principle: H. **Bateman** and E. **Cunningham.**—A certain family of cubic surfaces: W. H. **Salmon.**—Some fundamental properties of a Lebesgue integral in a two-dimensional domain: Dr. E. W. **Hobson.**—The relation between Pfaff's problem and the calculus of variations: Prof. A. C. **Dixon.**—(1) Implicit functions and their differentials; (2) indeterminate forms: Dr. W. H. **Young.**—Modular invariants of a general system of linear forms: Prof. L. E. **Dickson.**

DUBLIN.

Royal Dublin Society, January 26.—Prof. H. H. Dixon, F.R.S., in the chair.—The colours of Highland cattle: Prof. James **Wilson.** Four colours go to the making of Highland cattle. These are:—(1) the original black colour; (2) a brownish-black or blackish-brown, called *donn* in Gaelic; (3) red, introduced by Anglo-Saxon cattle; and (4) light dun, a lighter or silvery-grey, probably introduced from Scandinavia. These four colours by intercrossing produce five others. Black is dominant over red, and so no new colour is produced; but light dun crossed with red produces the hybrid yellow, and crossed with black the hybrid dun (registered as dun and dark dun), while brownish-black or donn produces hybrid brindles with black, red, and light dun.—Note on the tensile strength of water: Prof. H. H. **Dixon.** By using Berthelot's method tensions in water were obtained amounting to more than 160 atmospheres. The range of temperature over which these tensions were observed lay between 25° C. and 80° C. The water used contained large quantities of air dissolved in it. From the nature of the experiments the tensions obtained form a minor limit for the cohesion of air-containing water, its adhesion to the conducting tubes of plants, and its adhesion to glass and copper.—A new process of contact photography: E. E. Fournier **d'Albe.** Photographs are obtained by this process of any full-toned picture, letter-press, or diagram without the use of a camera. The picture is laid on a table with its face upwards, and a sensitive plate, film, or paper is placed upon it, with the film in contact with the picture. Exposure is made by means of light from above through the back of the plate or paper. The result is a faint negative, much fogged. The negative is developed with a view to the utmost "hardness," so as to minimise the fog and bring out the design. This principle is also applied to the positive printed from the negative, and the result is a good reproduction of the original. If necessary, the remaining fog can be cleared by two more reversals, preferably with "photomechanical" plates. The final result is a reproduction in bold black and white, perfectly free from fog and free from defects inseparable from all work done with a lens. It is proposed to call the process "anastatic" photography, by analogy with a disused lithographic process of the same name.

EDINBURGH.

Royal Society, February 1.—Prof. A. Crum Brown, vice-president, in the chair.—Magnetic quality in the homogeneous hexagonal arrangement of molecular magnets: Prof. W. **Peddie.** This was a continuation along the same lines of results already given for cubical arrangements of magnetic molecules.—An improved form of magnetometer for the testing of magnetic materials: J. G. **Gray** and A. D. **Ross.** When the usual east-west arrangement of a magnetising coil with auxiliary coil is used for compensating the direct action of the solenoid on the magnetometer needle, it is very difficult to ensure the accurate alignment of the axes of the two coils so as to be absolutely certain that there is no transverse resultant magnetic force in the north-south direction. In delicate work it is important to get rid of this possible inexact compensation, and at the same time to be sure that when the compensating coil is clamped in position the clamping does not bring in any change. The latter desideratum was attained by using two compensating coils at different distances from the magnetometer, the nearer one being set for rough adjustment, and the more distant one being then used for the fine and exact adjustment for balancing of the east-west fields at the position occupied by the magnetometer needle. The second adjustment was made after the nearer coil was clamped, and the sensitiveness was such that the second coil could be shifted through an appreciable distance without affecting the adjustment. The next step was to test for the existence of a north-south residual force. This was effected by first deflecting the magnetometer needle by means of a small permanent magnet suitably placed. On reversal of a powerful current through the magnetising and compensating coils, which had already been adjusted for east-west balancing, there was in general a change in the deflection, indicating the presence of a north-south component. A third coil was then suitably introduced either north or south of the magnetometer needle, and set in circuit with the other coils. By adjustment of the position of this third coil the change of deflection of the deflected needle, due to reversal of the current, could be wiped out. The small permanent magnet was then removed, and the magnetometer was in accurate adjustment for the purposes of testing magnetic quality. All the essential parts of the apparatus were mounted on a cross-shaped mahogany board, analogous in its broad features to an optical bench. Details were also given for facilitating testing from the temperature of liquid air up to high temperatures.—On the conditions for the reversibility of the order of partial differentiation: Dr. W. H. **Young.**

PARIS.

Academy of Sciences, February 8.—M. Émile Picard in the chair.—Observations of the sun, made at the Lyons Observatory, during the fourth quarter of 1908: J. **Guillaume.** The observations are summarised in three tables, giving the number of spots, their distribution in latitude, and the distribution of the faculæ in latitude. There was a much smaller total area of sun-spots visible compared with the previous quarter (3401 against 7893). Two spots were large enough to be visible to the eye unassisted.—Observations of the conjunction of Jupiter with χ Leo (4·8), made with the Brunner equatorial of the Lyons Observatory: J. **Guillaume.**—The integration of linear systems with a skew determinant: E. **Vessiot.**—The representation of a function with a real variable by a series formed with polynomials figuring in successive differential coefficients of the function e^{-a^2}: M. **Galbrun.**—A new radio-active product of the uranium series: Jacques **Danne.** In the separation of uranium X from 20 kilos. of uranium nitrate, a new radio-active substance was found, apparently the immediate parent of uranium X, for which the name radio-uranium is proposed.—The striæ of oscillating sparks: André **Léauté.** If a condenser is discharged through a coil carrying two layers of wire, the current passing through the coil has been shown by the author in a previous paper to be the sum of two sinusoidal currents. The frequency of the first is practically identical with that resulting from the application of Thomson's formula; the second has a greater frequency, and its existence furnishes a complete explanation of all the facts observed relating to striæ in induction sparks.—The mass of the negative ion of a flame: Georges **Moreau.** In a flame at a temperature of 2000° C. absolute, the mobility of the negative ion was found to be 1170 cm./volt : sec., and the velocity $2{\cdot}5\times10^{6}$ cm. : sec., the numbers being probably accurate to about 10 per cent. This leads to a value $(1{\cdot}1\times10^{-25})$ gr. as the mass of the negative ion, intermediate between the atom of hydrogen, $(1{\cdot}4\times10^{-24})$ gr., and a corpuscle, $(0{\cdot}75\times10^{-27})$, according to Perrin.—The *rôle* of the dissociation of the carbonophosphates in nature: A. **Barillé.** It has been shown in an earlier paper that carbonic acid combines with the phosphates of metals that are capable of forming bicarbonates, giving rise to easily dissociable compounds, the carbonophosphates. The intervention of these compounds is discussed as regards the formation of certain calculi, the absorption of carbon dioxide by the blood, sediments in urine, and as affecting

the nutrition of plants.—The combinations of gold with bromine: Fernand **Meyer.** The final product of the action of excess of bromine on gold is pure $AuBr_3$. This is soluble in bromine and volatile in an atmosphere of bromine at about 300° C. At temperatures at which $AuBr_3$ dissociates, two bromides only appear to exist, $AuBr_3$ and AuBr, the dissociation curves of which have been studied. There is no evidence of the existence of $AuBr_2$.—The coking power of coals: O. **Boudouard.** Coal was extracted with various organic solvents, of which only one, pyridine, dissolved an appreciable amount. The coking power of the extracted coal was unaffected.—Indigoid colouring matters derived from phenyl-isoxazolone: A. **Wahl.**—The chemical composition of colloidal silver: G. **Rebière.** A study of the electrical conductivity of solutions of colloidal silver prepared by Bredig's method leads to the conclusion that a part of the silver is in solution as oxide, or possibly carbonate.—The fertilisation of the poppy flower: Paul **Becquerel.**—The presence of amylase in old seeds: MM. **Brocq-Rousseu** and Edmond **Gain.** Wheat, fifty years old and incapable of germination, still contains diastases capable of transforming starch into sugar.—The gastric digestion of human milk and asses' milk: Louis **Gaucher.** The casein of these milks resembles that of cows' milk in not being peptonised in the stomach. Their great digestibility is due to the casein forming very small clots in the case of human milk, or a clot very easily broken up in the milk of the ass.—Parasitic protozoa of the intestine of the lobster: L. **Léger** and O. **Duboscq.**—The regeneration of the anterior part of the body in the Chetoptera: Ch. **Gravier.**—Some Plumulariidæ of the British Museum collection: Armand **Billard.**—A new protozoa from *Ctenodactylus gondi*: C. **Nicolle** and L. **Manceaux.**—The chemical treatment of bile. The separation of the biliary acids: M. **Piettre.**—The hypotensive action of d'Arsonvalisation in permanent arterial hypertension: M. **Letulle** and A. **Moutier.** The arterial pressure in these experiments was measured for each case with two independent instruments of different construction; the figures obtained were practically identical. The treatment with high-frequency current always caused a reduction in the arterial pressure.—Antimony in syphilis: Paul **Salmon.** Antimony in the form of tartar emetic is of service in the cure of syphilis, but in certain cases there is a rapid relapse.—The geology of Agôoué: M. **Arsandaux.**

DIARY OF SOCIETIES.

THURSDAY, FEBRUARY 18.

ROYAL SOCIETY, at 4.30.—On the Osmotic Pressures of Calcium Ferrocyanide Solutions, Part II., Weak Solutions: Earl of Berkeley, F.R.S., E. G. J. Hartley and J. Stephenson.—On the Spontaneous Crystallisation of Monochloracetic Acid and its Mixtures with Naphthalene: Prof. H. A. Miers, F.R.S., and Miss F. Isaac.—An Apparatus for Measurements of the Defining Power of Objectives: J. de G. Hunter.—On Best Conditions for Photographic Enlargement of Small Solid Objects: A. Mallock, F.R.S.

ROYAL INSTITUTION, at 3.—Problems of Geographical Distribution in Mexico: Dr. Hans Gadow, F.R.S.

LINNEAN SOCIETY, at 8.—Discussion on Alternation of Generations: opened by Dr. W. H. Lang.

FRIDAY, FEBRUARY 19.

ROYAL INSTITUTION, at 9.—Recent Advances in Means of Saving Life in Coal Mines: Sir Henry Cunynghame, K.C.B.

INSTITUTION OF MECHANICAL ENGINEERS, at 8.—Annual General Meeting.—*Further discussion*: The Filtration and Purification of Water for Public Supply: John Don.

INSTITUTION OF CIVIL ENGINEERS, at 8.—Standardisation in Engineering Practice: Dr. W. C. Unwin, F.R.S.

MONDAY, FEBRUARY 22.

ROYAL SOCIETY OF ARTS, at 8.—Modern Methods of Artificial Illumination: Leon Gaster.

ROYAL GEOGRAPHICAL SOCIETY, at 8.30.—A Recent Journey Across Northern Arabia: Captain S. S. Butler.

INSTITUTE OF ACTUARIES, at 5.—Some Financial and Statistical Considerations of the Old Age Pension Scheme: Vyvyan Marr.

TUESDAY, FEBRUARY 23.

ROYAL INSTITUTION, at 3.—The Evolution of the Brain as an Organ of Mind: Prof. F. W. Mott, F.R.S.

ROYAL ANTHROPOLOGICAL INSTITUTE, at 8.15.—Man and the Glacial Period: W. Allen Sturge.

INSTITUTION OF CIVIL ENGINEERS, at 8.—*Further discussion*: The Design of Marine Steam-Turbines: S. J. Reed.—*Probable Paper*: Some recent Grain-handling and Storing Appliances at the Millwall Docks: M. Mowat.

WEDNESDAY, FEBRUARY 24.

ROYAL SOCIETY OF ARTS, at 8.—Hand-made Papers of Different Periods: Clayton Beadle and Henry P. Stevens.

GEOLOGICAL SOCIETY, at 8.—Palæolithic Implements, &c., from Hackpen Hill, Winterbourne Bassett, and Knowle Farm Pit (Wiltshire): Rev. H. G. O. Kendall.—On the Karroo System in Northern Rhodesia, and its Relation to the General Geology: A. J. C. Molyneux.—On Coal-Balls from Japan: Dr. Marie C. Stopes.

BRITISH ASTRONOMICAL ASSOCIATION, at 5.

SOCIETY OF DYERS AND COLOURISTS, at 8.—A Series of Azo-dyes derived from the Aminosulphonamides: Dr. G. T. Morgan and Frances M. G. Micklethwaite.

THURSDAY, FEBRUARY 25.

ROYAL SOCIETY, at 4.30.—*Probable Papers*: The Statistical Form of the Curve of Oscillation for the Radiation emitted by a Black Body: Prof. H. A. Wilson, F.R.S.—The Flight of a Rifled Projectile in Air: Prof. J. B. Henderson.—On the Cross breeding of Two Races of the Moth *Acidalia virgularia*: L. B. Prout and A. Bacot.

ROYAL INSTITUTION, at 3.—Problems of Geographical Distribution in Mexico: Dr. Hans Gadow, F.R.S.

ROYAL SOCIETY OF ARTS, at 4.30.—The Bhuddist and Hindu Architecture of India: Prof. A. A. Macdonell.

INSTITUTION OF ELECTRICAL ENGINEERS, at 8.—*Further discussion*: The Use of Large Gas Engines for Generating Power: L. Andrews and R. Porter.

FRIDAY, FEBRUARY 26.

ROYAL INSTITUTION, at 9.—Osmotic Phenomena, and their Modern Physical Interpretation: Prof. H. L. Callendar, F.R.S.

PHYSICAL SOCIETY (at Finsbury Technical College, Leonard Street, City Road, E.C.), at 5.—A Laboratory Machine for applying Bending and Twisting Moments simultaneously: Prof. Coker.—On the Self-demagnetising Factor of Bar Magnets: Prof. Silvanus P. Thompson, F.R.S., and E. W. Moss.—Exhibition of Optical Properties of Combinations of Mica and Selenite Films (after Reusch and others) in Convergent Polarised Light: Prof. Silvanus P. Thompson, F.R.S.—Exhibition of Apparatus: C. R. Darling.

INSTITUTION OF CIVIL ENGINEERS, at 8.—Standardisation in Engineering Practice: Dr. W. C. Unwin, F.R.S.

SATURDAY, FEBRUARY 27.

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

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