THURSDAY, MARCH 28, 1912.

GABRIEL LIPPMANN.

Savants du Jour: Gabriel Lippmann. Biographie, Bibliographie Analytique des Écrits. By Ernest Lebon. Pp. viii+70. (Paris: Gauthier-Villars, 1911.) Price 7 francs.

UNDER the able editorship of M. Lebon, who enjoys a considerable reputation in his own country as a mathematician and mathematical astronomer, the enterprising firm of Gauthier-Villars is engaged in bringing out a series of monographs on the lives and achievements of the contemporary men of science of France. Up to the present the numbers published deal with the scientific careers of MM. Poincaré, Darboux, Picard, and Appell. Each memoir occupies from 70 to 80 large 8vo pages, printed on thick hand-made paper with ample margins, and containing a photogravure portrait of its subject, the whole constituting a remarkably handsome work well worthy of the reputation of the eminent publishing house concerned in its production.

The number before us treats of the life-work of Prof. Lippmann, the distinguished professor of physics of the faculty of science in Paris, member and vice-president of the Academy of Sciences, commander of the Légion d'Honneur, Nobel Laureate, and a foreign member of the Royal Society. M. Lippmann is known to all physicists more especially by his work on electro-capillarity, by his enunciation of the law of the conservation of electricity, and his notable contributions to the science and practice of colour photography. He is, however, the author of numerous memoirs in all branches of physics pure and applied. He has occupied himself in turn with the study of the phenomena of capillarity, Carnot's functions, the application of Coulomb's law to electrolytes, electrical measurements, the determination of the ohm, and the theory and mode of use of seismographic apparatus—a range of subjects which well serves to illustrate the many-sidedness of the man and the catholicity of his studies.

M. Lippmann, although born of French parents—his father was of Lorraine and his mother from Alsace—owes much of his inspiration to German influence. On the conclusion of the war of 1870 M. Lippmann had the courage to repair to Heidelberg, where he was welcomed by Kühne, Kirchhoff, Koenigsberger, and Lossen. In the first instance he was attracted by the problems of physiological chemistry, and worked with Kühne on the albuminous phosphates. But he soon abandoned chemistry for physics, and, entering Kirchhoff's laboratory, took up the study of electro-capillarity, which eventually culminated in his well-known memoir of 1875. He graduated at Heidelberg, and after a year at Berlin, under Helmholtz, he returned to Paris and became attached to the physical laboratory at the Sorbonne, then under the direction of Jamin, whom he eventually succeeded. The physical laboratory of the Sorbonne in those days was a wretched affair, consisting of some sheds and two or three rooms on the ground floor of a house in the Rue Saint-Jacques. M. Lippmann is far better housed to-day, but he has still a tender regard for the old shed in which he had worked with such signal success for upwards of twenty years.

M. Lebon's biographical notice is executed with taste and discrimination. Much of M. Lippmann's work has dealt with problems of the hour, and it has occasionally happened that he has been assailed by questions of priority, especially by certain English authorities. But M. Lebon deals with these matters impartially, and with an obvious desire to mete out strict justice to all concerned.

The analytical bibliography which necessarily constitutes a large part of M. Lebon's memoir has been carefully edited, and will be of great use to those to whom M. Lippmann's many publications are not readily accessible. M. Lebon's work is in every way a worthy contribution to contemporary scientific biography and a record of brilliant achievement, and as such we heartily congratulate both him and its subject on its appearance.

JOTTINGS OF A SPORTSMAN-NATURALIST.

Stalks in the Himalaya. Jottings of a Sportsman-Naturalist. By E. P. Stebbing. Pp. xxviii+321. (London: John Lane; New York: John Lane Company, 1912.) Price 12*s.* 6*d.* net.

IN a book with a title and sub-title of such import, there are certain things that one expects to find.

The naturalist—or even the plain unlabelled son of Adam—who has lifted up his eyes to the hills, and has considered the manifold works of the Lord therein revealed, looks for some brief account of their physical features, and of the ways in which these are being changed or confirmed by sun and frost and rain; for some brief account of their fauna, if not also of their flora, and of any adaptations or variations, or seasonal changes that can be discerned or suspected; for some occasional observations and well-founded reflections upon the general facies of the fauna of a tract where two great zoogeographical regions meet and overlap. If he be a naturalist of the old-fashioned kind, he will hope, when he eagerly opens a book dealing with the Himalayas, to catch some echo of the music of their melting snows and of their "wood-notes wild"—the scream of the marmot, or the joyful noise of the Dipper (Cinclus) heard above the turmoil of its native waters. He will hope for a few glimpses of their forest-clad buttresses, here aflame with rhododendron or with wild-rose, there dripping with orchid and lichen and moss; now standing out sharp as a two-edged sword, now engulfed in rolling billows of mist. He will hope to catch some reflection of the magic light of their blue and purple valleys.

The sportsman, on the other hand, will expect a good contour map of the country, some remarks on ways and means, on times and seasons, on weapons and kit, on shikaris and guides, and on a multitude of little things, like the effects of a rarefied atmosphere upon wind, eye, and judgment.

But in these Jottings of a Sportsman-Naturalist what the naturalist will find are some very ordinary descriptions of some of the larger mammals that live on the Himalayan slopes, served up along with accounts of certain open-air manœuvres by the author. Each animal is brought upon the stage, usually with some stereotyped introduction, such as "Have you ever had a chance of critically examining a large male serow upon the mountain side?" or "What a fine beast is a noble old ram"; and all the labours of the chase are duly emphasised.

The author describes well-known animals, such as the goral, the serow, the tahr, the markhor, the bharal, the urial, and the black bear, which he (like scores and scores of other men) has seen and followed and shot; the Kashmir stag and the brown bear, which he saw at a distance; and the snow-leopard, the ibex, and the so-called Sikkim stag, which he did not see. All these animals (except the Sikkim stag unseen of the author) have been fully described, again and again, though the author does not mention the fact, by Hodgson, and Blyth, and Jerdon, and Blanford—to name only a few of his many illustrious predecessors. Beyond mammals, he makes some remarks on the jungle-crow, and describes the colouring of three species of pheasants. He also gives several pages to "the lizard of the Himalaya," which he characterises as "an impudent and corpulent little beggar," and caricatures as a "paterfamilias" living with a "spouse," and chastising "a young hopeful."

Nor will the sportsman find much to please him. British officers, of course, have sometimes to be angry and sin, but one does not like to read of a sportsman constantly "turning angrily" upon his shikari, and being followed by grumbling orderlies, and congratulating himself that the rifle (luckily loaded) is in his own hands instead of in those of the enraged guide, and complaining because a rest-house is pre-occupied by people who appear to be extremely civil and considerate. And to all who know Indian servants, how staunchly they stand by their master in times of discomfort, it is positively painful to read of a sportsman whose servant reports unpleasant news "with a note of evil joy in his voice," and tells his weary and hungry master that there is no dinner because no specific order for that meal has been given. This is not the native servant that we all know. Most old Indians can tell of servants who would give and lose all rather than be untrue to their salt.

There are also little things in which the author is perfunctory. That famous old Himalayan shikari General A. A. Kinloch is always referred to as "Kinlock"; that Nestor of Indian naturalists the late W. T. Blanford is referred to once by his proper name, once as "Blandford"; and Dr. Syntax is several times outraged—as in the sentence, "Two essentials are absolutely necessary for he who," etc.

A book professing to deal, however informally, with natural history and wild sport must, quite apart from any literary standard, be also measured by other standards—educational, scientific, philosophical, or technical. By any of these standards this book cannot be classed. About the best thing in it is a plate of a range of snows, facing p. 30, and this is spoilt by a fancy label that leaves the locality unmentioned.

HYDRAULICS.

A Treatise on Hydraulics. By Prof. H. J. Hughes and A. T. Safford. Pp. xiv+505. (New York: The Macmillan Co. London: Macmillan and Co., Ltd., 1911.) Price 16*s.* net.

In a country so favourably situated for the utilisation of hydraulic power as is the United States, the growing interest in the study of the science of hydraulics, as marked by the rapidly increasing number of text-books on the subject, is not to be wondered at. The book under review is the joint production of the assistant professor of civil engineering and of the lecturer in hydraulic engineering at Harvard University, and is written as a text-book for university students.

An introductory chapter, dealing with the various units involved, is followed by three chapters devoted to hydrostatical problems. In this section, which occupies a somewhat large proportion—some seventy pages—of the book, the questions of the pressures on plane and curved surfaces, sluice gates and masonry dams, the thickness of pipe walls, and the equilibrium of floating bodies are adequately discussed, while a brief mention is made of piezometers and differential gauges.

Chapter v., which introduces the subject of fluids in motion, is very short and rather disappointing, Bernoulli's theorem, on which practically the whole science of hydraulics is founded, being introduced without any attempt at even an elementary and approximate proof of its truth.

Chapter vi. discusses briefly the flow of water, touching on the questions of hydraulic gradient, critical velocity, methods of measurement, and resistance to flow. In this connection the bald statement that in channels the resistance decreases with a rise in temperature certainly requires modification. In chapters vii. and viii. the Pitot tube and the Venturi meter are very adequately treated.

In chapter ix., dealing with orifices, the theoretical treatment is anything but scientific. The method adopted, common in the older text-books, consists in assuming that at all points at the same depth in the plane of an orifice, the velocity of efflux is the same, being that corresponding to the head of water above the point, and that the direction of flow at each point is perpendicular to the plane of the orifice. The discharge so obtained is then multiplied by an empirical constant to give the true discharge. Both assumptions are fundamentally unsound, and although the method leads to the usually adopted formulæ, its limitations should certainly be pointed out in any book intended for students. The chapter concludes with a good collection of experimental data, and is followed by a chapter on mouthpieces, including converging and diverging tubes, the experimental data in which are not quite so up to date. Chapter xi. is devoted to a discussion, extending over twenty pages, of Freeman's experiments on fire nozzles.

In chapter xii. the theoretical treatment of weir flow follows on similar lines to that of flow from orifices, but this is followed by a well-written discussion of the experiments and empirical formulæ of Francis, Bazin, Fteley and Stearns, and Smith, and of the United States Deep Waterways experiments on rectangular weirs. Triangular weirs and the trapezoidal weir are then considered, but broad-crested weirs are very briefly dismissed to a table in the appendix. Chapters xiii. and xiv., dealing with float and current-meter work, are good.

In chapter xv., the resistances to pipe flow and the losses at bends and valves are considered. The various exponential formulæ for pipe flow are practically ignored, the Chezy formula being the only one to receive detailed attention.

A good list of experimental data concludes a somewhat disappointing chapter. The flow in open channels is treated in the next chapter, the formulæ of Chezy, Kutter, and Bazin being well discussed. The forms of channel giving best results are given, without, however, any proof that these really are the best forms.

Chapter xvii. is devoted to the impact of water on fixed and moving vanes, and to water hammer. In the latter connection, no attempt is made to develop the simple formula for the rise of pressure following sudden stoppage of motion in a rigid pipe line, while the statement that the intensity of hammer pressures depends primarily on the volume of water in the pipe certainly needs amplification.

The final chapter deals with turbines and centrifugal pumps. The main outlines of the theories of the impulse wheel and of the reaction turbine are stated lucidly, and are illustrated with reference to actual examples. It was surely, however, a mistake to chose the 1895 Fourneyron turbines at Niagara for special mention as modern machines. The chapter is concluded by a very brief discussion, extending over three pages, of the centrifugal pump.

The impression left on the reviewer's mind is one of unevenness. The treatment of the fundamental theorems, on which, as a foundation, the science is built up, leaves a great deal to be desired, and as the book is intended primarily for students this is a matter of great importance. Those parts of the book which deal with experimental data are in general good, and in the hands of an instructor who would elaborate the foundation work it should give good results. The book is clearly printed and well illustrated.

A. H. G.

A HUNTER IN THE UPPER YUKON RANGES.

The Wilderness of the Upper Yukon: a Hunter's Explorations for Wild Sheep in Sub-Arctic Mountains. By Charles Sheldon. Pp. xxi + 354. (London: T. Fisher Unwin, 1911.) Price 12*s.* 6*d.* net.

THE volume before us is essentially a hunter's book, and will be most appreciated by those to whom all incidents of the chase are gratifying. Nevertheless, in Mr. Sheldon the crude hunter is blended and tempered with the field-naturalist, so that his range of observation often goes beyond the requirements of sport. Also, as a hunter, on this occasion he took up the *rôle* of specialist, and set out to kill selectively and not indiscriminately. His quarry was the mountain sheep of the Upper Yukon basin; for it was incidentally his object to clear up the relationship of the local varieties or subspecies of this animal. In the event he is able to show that the three forms *Ovis dalli, O. fannini, and O. stonei* merge imperceptibly into each other.

The main hunting-grounds described in the book lie in three separate parts of the little known mountainous country forming the eastern side of the Upper Yukon basin, and in each case the author believes that he broke new ground. His descriptions of the wild life of the region are touched in graphically, yet with due restraint; while the physical features of the land are readily deducible from the narrative and from the accompanying illustrations.

It is inevitable in a book of this type that there will be passages likely to give pain to a reader to whom the slaughter of wild animals is repellent. For instance, anyone but a toughened hunter may wince, after reading of the killing of a she-bear, to find mention of "the wailing of the cub pealing wildly through the mists above" among the author's night-impressions that brought to him "the wild enchantment of the wilderness" (p. 30). In recording another and still more painful incident of the chase, the author himself is moved to consider the singular psychology of the hunter-sportsman in whom "an intense fondness for the wild animals" is combined with "his paradoxical love of hunting and killing them" (p. 46). Is it not, indeed, just one among the many of men's doings in which there is a present-day clash between old-rooted instincts and new-born sympathy, with instinct proving in most of us, as yet, the stronger?

One of the author's journeys was made in companionship with another mighty hunter, Mr. F. C. Selous, who has already published an account of the trip. Thus, in a few instances, the sportsman-reader can refer to two separate and independent narratives of the same chase.

The author's sincere eulogium on the ably-recorded exploratory work of the late Dr. G. M. Dawson, of the Geological Survey of Canada, on the head-waters of the Yukon (pp. 185–7), will be read with pleasure by all who cherish the memory of that most capable and indomitable man.

Besides its numerous photographic illustrations of the usual type, the book is embellished with some spirited coloured pictures of animal life, by C. Rungius. The appendices include a short bibliography; a list of animals; a reprint of the original descriptions of northern sheep; and a table of horn-measurements.

G. W. L.

HANDBOOKS ON ANALYTICAL CHEMISTRY.

(1) *Huiles Minérales: Pétroles, Benzols, Brais, Paraffines, Vaselines, Ozokérite.* By Henri Delahaye. Pp. 215. (Paris and Liège: Ch. Béranger, 1911.) Price 4 francs.

(2) *Matières Tannantes Cuirs: Gélatines, Colles, Noirs, Cirages.* By L. Jacomet. Pp. 249. (Paris and Liège: Ch. Béranger, 1911.) Price 5 francs.

(3) *Soude-Potasse-Sels: Dénaturation des Sels.* By P. Méker. Pp. ii+245. Paris and Liège: Ch. Béranger, 1911.) Price 5 francs.

(4) *Alcools: Alcool, Alcool Dénaturé, Dénaturants.* By M. Louis Calvet. Pp. viii+376. (Paris and Liège: Ch. Béranger, 1911.) Price 6 francs.

(5) *Les Matières Cellulosiques: Textiles Naturels et Artificiels Pâtes à Papier et Papiers.* By Prof. F. J.-G. Beltzer and J. Persoz. Pp. xv+454. (Paris and Liège: Ch. Béranger, 1911.) Price 7.50 francs.

(Manuels Pratiques d'Analyses Chimiques. Publiés sous la direction de M. F. Bordas et M. E. Roux.)

THESE five volumes belong to a collection of practical manuals of analytical chemistry produced under the direction of MM. Bordas and Roux; they are intended for the use of French official laboratories, and of technical chemists generally. They give an outline of the chemistry of the products in question, with concise directions for the analytical examinations required. In the case of the first four volumes, the purely chemical matter is supplemented by copies of the official stipulations or fiscal regulations bearing on the use of the various commodities in France, and, in the case of alcohol, in other countries also.

(1) In this work the opening chapter deals with the definition and classification of petroleum products, leading up to the detailed instructions for their analysis and discrimination. The usual physical and chemical operations required in the technical examination of these products are described, including the determination of the density, viscosity, flashing-point, behaviour on burning, and examination by fractional distillation. Following this comes a section upon the interpretation of the results obtained; this includes a number of examples *in extenso,* illustrating the methods of distinguishing between Russian, American, and Roumanian types of petroleum products. Shale oils, paraffins, mineral waxes, bitumens, and benzols are each accorded a short section; whilst an appendix includes descriptions of certain special methods devised to discriminate Russian from American petroleum, and also to solve the problem—not always a simple one—of

analysing mixtures containing members of both the paraffin and the benzene series of hydrocarbons. Within its somewhat limited scope, the volume is a useful laboratory handbook.

(2) The last remark applies also to M. Jacomet's little work on the chemistry of tanning materials and leather. The recognised methods of examining these products are given, including Proctor's well-known tables for the identification of natural tannins, and those of Andreasch for the recognition of the particular tannin which has been employed in producing a given specimen of leather. In addition, sections are devoted to other substances connected with the leather industry, such as glue, gelatine, gum, and other adhesives, varnish, and polish; these sections are by no means the least valuable. The work is packed with the kind of information which the leather chemist wants in his everyday tasks, and it deserves a cordial word of praise.

(3) More than a third of this volume is taken up by copies of the French fiscal regulations relative to soda and salt. Of the remainder, a substantial proportion has reference to the analytical examination of denatured salt—that is, salt which, to exempt it from taxation, has been rendered unfit for table use by an admixture of various substances, ranging from wallflower essence to sulphate of mercury. For a free trade country this has only a remote interest. The rest of the book contains concise directions for the analysis of sodium and potassium hydroxides, and of such of the salts of these elements as have pharmaceutical or industrial importance.

(4) The "alcohols" which form the subject of this volume are the various forms of ethyl alcohol used in manufactures. Spirituous liquors employed as beverages are excluded. In addition to details of the methods for estimating secondary products (fusel oil, aldehydes, esters, acids) required in the ordinary analysis of commercial alcohol, the chemical matter comprises descriptions of the official methods used in France and other countries for the detection and determination of various denaturing substances. These include methyl alcohol, acetone, "benzine," ether, turpentine, mercuric chloride, pyridine, and so forth. A few unofficial processes are also given, but the author disclaims any attempt at bringing together all the known analytical methods which have been devised for examining alcohol. A chapter which will occasionally be useful to the specialist gives a *résumé* of the legislative enactments concerning industrial alcohol in European countries and in the United States. It has not been brought up to date, however, so far as the United Kingdom is concerned; the "ordinary" methylated alcohol described on p. 63 was abolished more than five years ago, and its place taken by "industrial" alcohol, denatured with five (not ten) per cent. of wood naphtha.

The work includes a number of tables for use in alcoholometry. It is a serviceable volume, but is written, of course, especially from the French point of view.

(5) Considering the small size of this volume, and its other contents, the authors have managed to give in it a very full account of the chemistry of cellulose, so far as we at present know it. The constitution of the cellulose molecule is still a matter of debate, though something substantial has been done towards the elucidation of the problem. In the celluloses and their compounds it has been shown that alcoholic, aldehydic, and ketonic properties exist, and theories of constitution based on these and other facts have been proposed. Useful in a provisional and suggestive sense these theories certainly are, but none are regarded as definitely established, and until the question is settled the chemistry of cellulose must remain a more empirical matter than that of benzene and its derivatives, for example.

The present position can be gathered from the volume under notice, and the authors express the hope that their work will facilitate research by guiding the reader through the maze of published investigations. This it is well calculated to do. It does not, however, deal only, or mainly, with the pure chemistry of the subject. It is essentially a practical treatise, and gives working details of the examinations required in the various branches of the industry. The theoretical side is nevertheless kept in view, and copious references are supplied. In the sections devoted to lignocelluloses and paper there are numerous illustrations of fibres and apparatus.

Judging by the five examples now published, this series of handbooks promises to be a useful and trustworthy one.

C. S.

OUR BOOKSHELF.

An Australian Bird Book: a Pocket-book for Field Use. By J. A. Leach. With introduction by Frank Tate. Pp. 200. (Melbourne: Whitcombe and Tombs, Ltd., 1911.) Price 3*s*. 6*d*.

THIS useful book is intended as a pocket-book for field use to enable teachers and observers generally to name the birds they meet with. It deals with 395 species—a considerable proportion of the Australian avifauna, the balance being made up mainly of birds closely related to those of which illustrations are given, or of very rare birds restricted to a small area. The plan of the book is to indicate by numbers the strength and distribution of the various families of birds over the world in general, and especially in Australia, and to give a concise description of each species. This includes the local name or names (if any); its distribution in Australia; its status—whether stationary or migratory, comparative abundance, &c.; the kind of country it frequents; a short description of its size and plumage, and a few words as to its song or other notes, and its food. All the species are illustrated, and in the majority of cases are figured in colours as well as in black and white. The illustrations are, with few exceptions, from specimens in the National Museum.

In addition to this useful and necessary, but somewhat dry, portion of the handbook, about a third of the little volume is occupied by a most interesting lecture on the Australian avifauna. Thus the book appeals to a much wider class of naturalists than that for which it has been mainly written. For the ornithologists of other countries will find in it an excellent introduction to, and a valuable account of, the birds of a very interesting part of the world. Mr. Tate in his introduction alludes to the growth of a generation trained to look upon the characteristic beauties of Australia with an appreciation almost unknown to their pioneering fathers and mothers, and he combats the popular belief that their birds are songless. An index to the coloured plates and a general index make reference to any particular bird easy.

Unity in Nature: an Analogy between Music and Life. By C. E. Stromeyer. Pp. x+589. (London and Manchester: Sherratt and Hughes, 1911.) Price 12*s*. 6*d*. net.

THIS is a readable discourse on things in general, from physics and astronomy to ethics and politics. As the title indicates, the author expounds certain musical analogies, such as the relation between intervals in the octave and distances in the solar system; but, after the first few sections, the matter of the book becomes more general. There is a good deal of amusingly-put speculation about the kind of world that a "flatland" of two dimensions would be (as sketched by Mr. Hinton), and this, of course, leads to fourth-dimensional space and what might happen there. Then, after a chapter on sexual ethics in which a more or less Schopenhauerian doctrine is taught—with much apt illustration, historical and geographical—we come to the female suffrage question, on which the author has vigorous opinions. If women get the vote, "there is every probability that female Members of Parliament would soon be elected; these would decide to elect female Prime Ministers, and as Parliament claims to be omnipotent, there is the prospect of having autocratic female rulers" (p. 507). Also on the disproportionate number of lawyers in Parliament Mr. Stromeyer has some cutting and probably justified remarks; and on education he enters a wise protest against too much classicism. The punctuation of the book leaves something to be desired, and on p. 104 "bromide" appears several times when "bromine" is meant; but these are small details. The author shows wide culture and has a pleasant style.

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.*]

Prof. Bergson and the Eye of Pecten.

I FIND that Prof. Bergson in his Philosophies has been making use of a comparison between the eye of Pecten, the scallop, and the vertebrate eye. This comparison is used as the basis of some far-reaching conclusions, and therefore it becomes important to direct the attention of readers of NATURE to the fact that the example taken is an extremely bad one. Prof. Bergson states that the eye of Pecten agrees in the most minute details with the vertebrate eye. Now there is no resemblance whatever either in structure or development between the two. The only feature possessed in common by both eyes is an inverted retina, and this is by no means unique in the animal kingdom.

W. J. DAKIN.

University of Liverpool, March 19.

Mersenne's Numbers.

AT various times NATURE has inserted notices of the successive discoveries in relation to Mersenne's Numbers. In the issue of August 12, 1909, Colonel Cunningham's discovery that 228479 was a factor of 2^p-1 when $p=71$ was announced: the other factor was 10334355636337793, but whether this was a prime or not was left undetermined. The same result was discovered last January by Mr. Ramesam, of Mylapore, Madras, and he subsequently resolved the larger factor into the product of 48544121 and 212885833. I think these results may be of interest to some of your readers.

W. W. ROUSE BALL.

Trinity College, Cambridge, March 23.

The Electrolytic Transportation of the Active Deposit of Actinium through Pure Water.

IN the course of some detailed investigations on the conditions of the electrolysis of some radio-active products, I have encountered in the case of actinium the following phenomenon. The products of the active deposit of actinium, though apparently not soluble in water under ordinary conditions, under the action of electric force could be driven from the anode in the state of ions into the water, and eventually transported to the kathode. The experiments were as follows.

The active deposit of actinium was collected on the surface of a platinum plate exposed during some hours as a negative electrode in the emanation of actinium. Immediately after the removal of the plate from the emanation, its activity was measured by means of an electrometer, and the beginning of the curve of its decay was determined. The plate was then immersed in pure, several times distilled water, and formed the anode during the electrolysis of the water. The kathode was also a platinum plate. The activity of the anode was again measured after the electrolysis. It could be seen that the plate was in certain conditions deprived by the electrolysis of a great part of its activity, especially in the case when a very great electromotive force (220 or 440 volts) was applied. If the current passed through the water during a longer time (2 or 3 min.), and the distance between the electrodes was not too great (1 or 2 cm.), a great part and often the total activity lost on the anode could be detected on the kathode. The activity of the kathode proceeded not only from actinium C and probably actinium D, but also the product actinium B was undoubtedly present. (New nomenclature after Rutherford and Geiger, *Phil. Mag.*, 22, p. 621, is used throughout this communication.)

Closer investigations of the conditions of this phenomenon established the fact that this removal of the active products from the anode took place only in the case when the activated plate serving as anode was used during a preceding electrolysis of water as kathode, or, in other words, was previously electrolytically saturated with hydrogen. This saturation of the plate with hydrogen was found as the necessary condition for making possible the removal of the radio-active products from the anode. The atoms of the active deposit were driven under the action of the great applied electromotive force as ions into the pure water. If the plate had been previously sufficiently saturated with hydrogen, and used then as anode, it was possible by applying a great P.D. to drive from it into the water in a few seconds a great part, viz. up to two-thirds, of the active products deposited on it. On the other hand, it was not possible to deprive the plate of its total activity even by applying a P.D. of 840 volts, nor by electrolysis during half an hour. The more detailed results of these investigations will be given elsewhere. TADEUSZ GODLEWSKI.

Lemberg, Physical Laboratory of the Technical High School, March 18.

Autophanous Eyes.

I HAVE been greatly interested by the correspondence lately appearing in NATURE on the subject of eyes gleaming in the dark, and there are one or two points about which I should much like to hear a little more.

With regard to human eyes never glowing, I knew one case some years ago of a young Scotch girl whose eyes glowed with a distinct deep-red light. She was a fair-complexioned girl with auburn hair and the peculiar red-brown eyes which go with that colouring.

On the subject of cats' eyes, can anyone tell me why the glow is invariably red in blue-eyed cats and green with yellow or green eyes, *as the glow is not from the iris, but from the tapetum?* I had a half-Persian cat for years with one blue and one yellow eye, and in the dark they were perfect little "port" and "starboard" lights. The red glow of the blue-eyed cat, whether Persian or Siamese, is a deep ruby (not spinel like a mouse's eyes), and is noticeable even with tiny kittens before the colour of the iris is developed at all.

With Persian kittens it is possible to tell as soon as their eyes are open whether they will have blue or yellow eyes by placing them so that the glow can be seen, *i.e.* with a light in line with the observer's own eyes, those which will later develop a blue iris showing like rubies, and the future yellow or green iris like emeralds. Having at present six Siamese cats (fawn-coloured, with deep-blue eyes) and a Persian (black, with yellow eyes), I have considerable opportunities of observing them.

CHARLOTTE I. WHEELER CUFFE.

Brachead, Kokine, Rangoon, March 1.

THE phenomenon of "glowing" eyes (autophanous or not) is certainly observed in man. Without taking much interest in the matter, I have noticed three cases, one abroad and years ago, and the other two quite recently in London. In Room 10 of the L.C.C. Technical Institute, Dalston Lane, N.E., with all lights switched on, I observed the phenomenon over and over again by standing between the lecturer's table and the front bench and looking down at the student sitting in the middle (who should be looking up at you). I should add that I assumed the matter to be a function of the position after I had seen it in two students; before then I thought it was a peculiarity of the one student. H. DE S.-P.

Sibpur College, Calcutta, March 7.

RAND GEOLOGY.[1]

IN no other part of the world is the work of the geologist linked up with such varied interests as in the little strip—some fifty miles long—of high tableland in the Transvaal known as the Witwatersrand, on which are situated some sixty producing gold-mines with an annual output of 350 *tons* of fine gold, worth 35,000,000*l.*; and, indeed, in no other district has the geologist such opportunities for prosecuting his researches as are afforded by the innumerable prospecting trenches, shafts, and deep borings that have been put down on the Rand in the search of extensions, along the strike and on the dip, of the auriferous conglomerates. Hundreds of thousands of pounds have been spent on prospecting work of this nature. In one area alone near the Springs, in the East Rand, the writer of this review had the technical supervision of a series of deep borings, costing above 30,000*l.*, and successfully located the eastern end of the Witwatersrand syncline, with its valuable gold-bearing seam there concealed beneath a thousand-foot cover of the later unconformable Dolomite formation.

The Transvaal Geological Survey, which, since its reconstruction after the war, has been working mainly in the northern part of the Transvaal, has at last broken ground on the Witwatersrand, and the report for 1910 contains an important instalment of this work, in which Dr. Mellor[2] summarises the results of his mapping of the lower Witwatersrand beds between Maraisburg and Rietfontein, an area including the municipality of Johannesburg and the Bezuidenhout valley, the geological structure of which presents so many points of interest. The main features of this area have long been known: they were sketched broadly by Walcot Gibson in a paper read before the Geological Society in 1892; and the boundary lines of the various subdivisions of the Witwatersrand beds were mapped by Messrs. Hatch and Corstorphine, and published in the Transactions of the Geological Society for South Africa for 1904.

Dr. Mellor's mapping of these subdivisions agrees in the main with that of his predecessors; but he explains the duplication of the lower Witwatersrand beds by a new reading of the faulting, which on his view took place subsequently to the extrusion of the Klipriversburg amygdaloid. His map also records a hitherto unnoticed strip of sheared granite on the farm Rietfontein No. 145, that throws fresh light on the age of the movements responsible for the dislocations. The publication of the further work of the Survey on the Rand, especially at its extreme eastern and western ends, will be awaited with interest.

F. H. H.

[1] Report of the Geological Survey for 1910, Union of South Africa Mines Department, Pretoria, 1911. Pp. 113, with 9 plates and 5 maps Price 7*s.* 6*d.*

[2] "The Geology of a Portion of the Central Witwatersrand." By E. T. Mellor. Pp. 22–38 of the Report.

WESTERN CULTURE IN ANCIENT CATHAY.[1]

IN the two magnificent volumes before us, Dr. Stein, the pioneer explorer of the now famous antiquities of the Central Asian deserts, gives us the personal narrative and general results of his last great expedition of 1906–08 to the more eastern deserts of Turkestan and north-western China.

The results achieved far surpass in importance and interest even those of his own former expedition in Western Turkestan, as well as those sent out in the interval by more than one European Government, attracted to that important historical field by Dr. Stein's great discoveries. For again Dr. Stein has been the first to explore systematically the ruins of the ancient settlements along a fresh section of the old-world highway between China and the Ancient West. His unequalled knowledge and equipment for this research, combined with his previous practical experience gained in those deserts, have enabled him to unearth from the protecting sand an astonishing amount of material for reconstructing several lost chapters in the history of the world's early culture. The sites excavated and otherwise explored proved to be connecting links between ancient Chinese civilisation and the classic West, and have revealed a remarkable intrusion of Western elements into the art and mythology of Ancient China.

Amongst these Western elements the Grecian influences are conspicuously prominent. They were obviously introduced about the first century of our era with Buddhism from the Greco-Bactrian provinces of Gandhara (Peshawar), Afghanistan, Swat, &c., to the north of India, in which Buddhism had become established as the State religion by the successors of Alexander's satraps. This school of Greco-Buddhist art, saturated with Western ideals, and known as "Gandhara," after one of its chief centres above-named, is represented in many of our museums by its fine friezes and statues obtained from the northern frontier of India. It is now found by Dr. Stein to have extended in the early centuries A.D. nearly two thousand miles further eastwards to the very threshold of China. At Niya, in Turkestan, the Caves of the Thousand Buddhas at Tun-huang in Western Kansu, and elsewhere, on the border of the Gobi Desert, Dr. Stein found a rich statuary had grown up and flourished, which faithfully reproduced the style and motive of the Gandhara, and was even more purely classical Hellenist. Transitional stages in the process of naturalisation on Chinese soil of those exotic influences are also represented, and connect the ancient types with pictorial and decorative art in medieval and modern China, and through the latter with Japan. Indigenous Indian Buddhist art is also present.

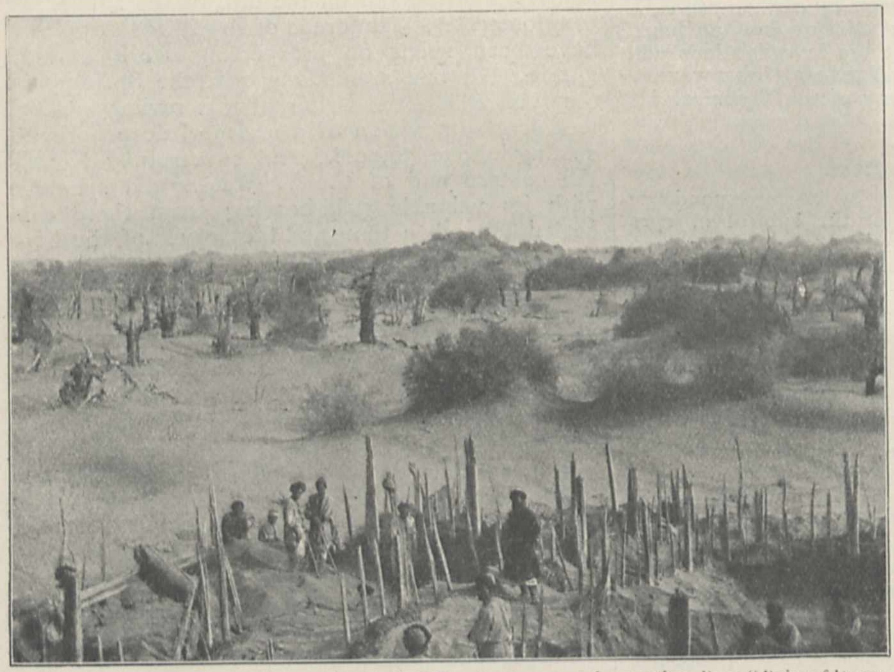

FIG. 1.—Ruin of ancient dwelling at southern end of Niya site, in course of excavation. From "Ruins of Desert Cathay."

One of the most dramatic and fruitful incidents in the history of archæological discovery occurred at the temples of the "Thousand Buddhas," where the piety of early times had honeycombed the rocks with hundreds of cave-temples, richly decorated with frescoes and stucco sculptures. Here our author had the good fortune to gain access to a great deposit of ancient MSS. and art relics which had lain hidden and perfectly protected in a walled-up rock chapel for about nine hundred years. Most of these treasures are now deposited by Dr. Stein in the British Museum and India Office, and the remainder was subsequently gleaned thoroughly by M. Pelliot.

The treasures of ancient art and industry recovered during the expedition include some of the actual frescoes and mural paintings, which are now safely deposited in admirable preservation in the British Museum. The infinite pains necessary for the successful transport of these fragile objects may be imagined when it is remembered that the author's caravan had to traverse the most difficult country in the world, and covered an actual distance by land of close on ten thousand miles.

Of the several thousands of ancient MSS. and

[1] "Ruins of Desert Cathay." Personal narrative of Explorations in Central Asia and Westernmost China. By Dr. M. Aurel Stein. Vol. i., pp. xxxviii+546+plates+map. Vol. ii., pp. xxi+517+plates+maps. (London: Macmillan and Co., Ltd., 1912.) Two vols., 42s. net.

other documents on wood, leather, and clay, as well as on paper, thus recovered, some are official secular documents throwing light upon the everyday life and history of that early period. The majority are religious, mostly Buddhist, but also Taoist, Manichæan, and Nestorian Christian; and the writing is in the ancient Indian Brahmi and Kharoshthi characters, in a Sanskritic language, also in Chinese, Tibetan, Sogdian, archaic Turkish, and several are in "unknown" script. The detailed reports on this vast mass of material are under preparation, with the collaboration of experts, and will take several years to complete. Of the geographical results, which gained for Dr. Stein the Founders' gold medal of the Royal Geographical Society, we have an instalment in several excellent maps in the volumes. Scientific observations were also made upon the general desiccation of the area, and the advance of the desert, with the resultant changes in the sites of the settlements under the altered economic environments. A large series of anthropometric measurements was secured, and is to be eventually published.

The personal narrative now chronicled is of fascinating interest. It is told with vivid clearness and in charming style, and through it all we feel the haunting presence of the great deserts. The splendid photographs, taken by Dr. Stein himself, which adorn the book are superb, and many of them reproduce the paintings and frescoes in colours by photomechanical processes with great technical accuracy and beauty.

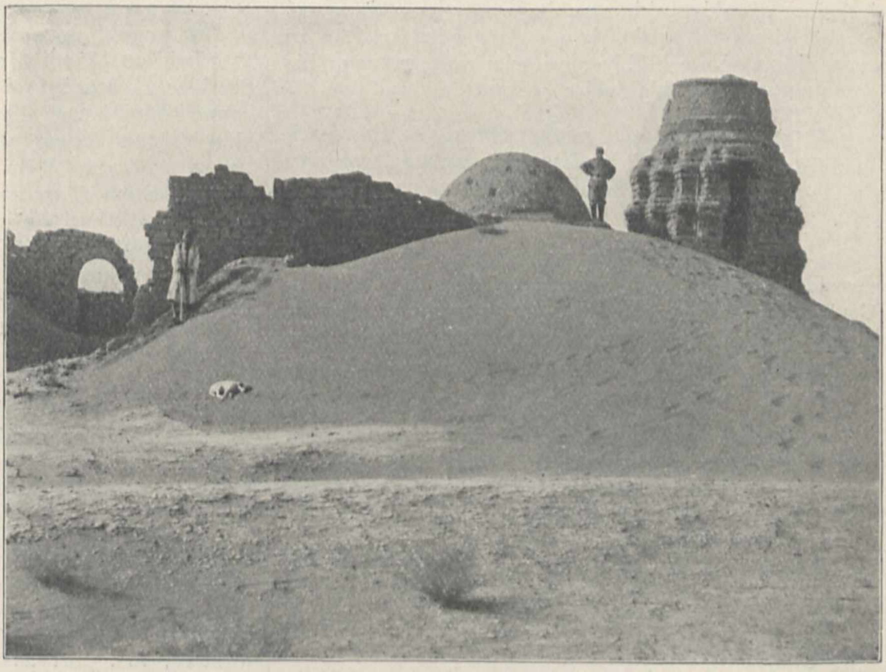

FIG. 2.—Ruins of small Buddhist stupa and shrine at Kichik-Hassar, Turfan. From "Ruins of Desert Cathay."

The methods of research revealed by these pages are most instructive. The author combines in his personality all those qualities that are essential for the highest achievement in archæological research. A scholar and archæologist of repute with the practical experience, resourcefulness, and physical vigour of the trained explorer, he is able to penetrate to the most remote regions, and, though isolated, yet instinctively to miss no clue or opportunity that may present itself. His sympathetic insight and attitude towards the shy and usually suspicious nomads amongst whom he moved, and on whose assistance he largely depended in his research, won him at every turn the entire confidence of these people, who even became inspired with some of his own abounding enthusiasm. His unfailing tact smoothed over many difficulties; his foresight and business talent in leaving nothing to chance contributed much to the ultimate success of his plans. With inexhaustible energy and devotion in the pursuit of science he bravely and cheerfully faced and endured great privations and actual frostbite.

The magnificent results he has achieved are worthy of such great self-sacrifice. But what is the reward desired by this intrepid scholar, with such unique qualifications for archæological Oriental research? In his concluding sentence he says: "When may I hope that the gate will open for work in those fields to which cherished plans have been calling me ever since my youth, and which still remain unexplored?" It is to be hoped that this appeal in the interests of science may soon be realised. May the Government of India at no distant date enable our author to proceed to Badakhshan and the Upper Oxus region (to the north-west of India) to recover the Western connecting links between the ancient culture of the Orient and the Near East and West, which still await the masterly discovery by such a peerless explorer as Dr. Stein has proved himself to be.

L. A. WADDELL.

NOTES.

A CONSIDERABLE area of "submerged forest" has recently been laid bare at Freshwater West, Pembrokeshire, owing to extensive shifting of sand and shingle by a gale in conjunction with an unusually high spring tide, and has been examined by Lieut.-Colonel F. Lambton. Stumps of trees rooted in place are frequent, embedded in a foot or so of peat covering an old land-surface. No implements appear to have been found, but there is little doubt that the deposit is of the same age, viz. Neolithic, as the similar formation found elsewhere along our coasts.

The vegetable matter has darkened, but shows no other resemblance to coal, the statements in the daily Press on this, as on other points, being erroneous. Much is soft and pulpy, but some is still hard and flexible. In some overlying beach-sand of the same general age, part of the skull of a whale, probably the common rorqual, has been found, together with a great quantity of drift-wood in the same condition as the wood *in situ*. This beach-sand is now partly cemented with pyrites.

THE council of the Iron and Steel Institute has decided to award the Andrew Carnegie gold medal of the institute to Dr. Paul Goerens, of Aachen. Dr. Goerens has made many contributions to scientific metallurgy, and in 1910 he was awarded one of the Carnegie scholarships of the Iron and Steel Institute, to enable him to pursue his investigations on the influence of cold-working on the properties of iron and steel. The gold medal is now awarded to him in recognition of the highly meritorious character of his research work on this subject.

WE regret to see the announcement of the death of Prof. A. Pacinotti, professor of technical physics at the University of Pisa, at seventy-one years of age.

DR. J. C. WILLIS has retired from the post of director of the Royal Botanic Gardens, Peradeniya, Ceylon, and has accepted the appointment of director of the Botanic Gardens (Jardim Botanico) at Rio de Janeiro. He will sail by the *Orcoma* from Liverpool on April 4.

THE death is announced, at the age of seventy-six years, of Prof. Auguste Töpler, who from 1876 to 1900 was head of the physics department of the Technical High School of Dresden, and was the inventor of the well-known mercury pump bearing his name. We also notice the announcement of the death, at sixty-nine years of age, of Prof. Wilhelm Münch, professor of pedagogics at the University of Berlin.

THE death is reported, in his fifty-fifth year, of Dr. John Bernhardt Smith, a well-known American writer on entomology. He was educated for the Bar, and practised as a lawyer for several years. His first scientific appointment was as assistant curator of insects in the United States National Museum in 1886. In 1889 he became professor of entomology at Rutgers College, and in 1894 State entomologist of New Jersey. In the latter capacity he did much to get rid of the mosquito pest in that State.

DR. WILLIAM TRELEASE has resigned his post as the director of the Missouri Botanical Garden, familiarly known in the United States as Shaw's Garden. Dr. Trelease was appointed director of the garden by the late Mr. Henry Shaw, its founder, on the recommendation of Prof. Asa Gray, and has held the position since 1889. The garden is exceeded in size only by Kew Gardens. The director's report for 1909 shows that at the end of that year the garden contained 11,764 species, representing 1777 genera belonging to 197 families. The number of visitors during the same year was 120,748, a number exceeded only in 1907, when the total reached 135,497.

THE tenth annual session of the South African Association for the Advancement of Science will be held in Port Elizabeth from Monday, July 1, to Saturday, July 6, inclusive, under the presidency of Dr. A. Theiler, C.M.G. The sections and their presidents are as follows:—A, astronomy, mathematics, physics, meteorology, geodesy, surveying, engineering, architecture, and irrigation, Mr. H. J. Holder; B, chemistry, geology, metallurgy, mineralogy, and geography, Prof. B. de St. J. van der Riet; C, bacteriology, botany, zoology, agriculture, forestry, physiology, hygiene, and sanitary science, Mr. F. W. FitzSimons; D, anthropology, ethnology, education, history, mental science, philology, political economy, sociology, and statistics, Mr. W. A. Way.

THE annual general meeting of the Ray Society was held on March 14; Dr. B. Daydon Jackson, vice-president, occupied the chair. The report of the council announced a small increase in the membership of the society; the issue of two volumes for the year 1911, "British Desmidiaceæ," vol. iv., and "British Tunicata," vol. iii., completing that work; and that the volumes for 1912 would be a "Bibliography of the Tunicata," by the secretary, and the first volume of "British Parasitic Copepoda," by Dr. Thomas Scott and Mr. Andrew Scott, treating of the copepoda parasitic on fishes, which division of the subject would be completed by the issue for 1913 of an atlas of seventy plates, mostly coloured. The balance-sheet showed the finances of the society to be in a satisfactory condition. The Right Hon. Lord Avebury was re-elected president, Dr. F. DuCane Godman treasurer, and Mr. John Hopkinson secretary.

THE report of the Departmental Committee on Forestry in Scotland has been issued as a Blue-book (Cd. 6085). It will be remembered that the terms of reference to the committee were, among other matters, to report as to the selection of a suitable location for a demonstration forest area in Scotland, the uses to which such an area could be put, and the probable cost. The committee thinks the area should contain at least 4000 acres, including, if possible, 2000 acres already under wood. The plantable land might with advantage amount to 10,000 acres, but, says the report, such an extent, combined with the necessary growing woods, may be difficult to secure. Recommendations are made as to the staff required and to equipment, and so on. No estimate is given of the probable capital expenditure, though the estimate of capital outlay for establishment is placed at 15,500*l.*, and the estimate of initial annual expenditure at 2400*l.* Three steps are recommended following on the establishment of a demonstration area for the promotion of sylviculture in Scotland: a flying survey to ascertain the best forest sites and their approximate extent; the appointment of an advising forest officer, with at least one assistant; and the establishment of a limited number of State trial-forests.

IN a paper recently contributed to the Proceedings of the British Academy, Mr. D. G. Hogarth discusses certain problems of Hittite history in relation to the excavations now in progress under the control of the British Museum at the mound of Jerablus, the Carchemish of the Old Testament. These excavations are still only in a preliminary stage, but sufficient evidence has already been collected to prove that there were Hittites, or at least Hittite influences, in Syria before its conquest by the king of the Hatti of Boghaz Keui; that the Cappadocian occupation established by the latter did not eliminate the earlier stock at Carchemish, and was not very long-lasting; and that it was succeeded by a period of independence of Cappadocia and dependence upon Assyria, prior to complete conquest by the latter power. The exact relation of this Syrian culture to that of Mesopotamia, Assyria, and the Ægean is a problem on which these important excavations may be expected, at an early date, to throw welcome light.

IN an article on megalithic remains in Gloucestershire, contributed to the March issue of *Man* by Mr. A. L. Lewis, the question is raised whether the chambered barrow at Uley was used for the cult of the dead so late as Roman times. This theory was advocated by Mr. W. C. Borlase ("The Dolmens of Ireland," p. 974), who laid stress on the discovery of a Roman lachrymatory in one of the side chambers. Mr. Lewis sees no reason to object to this view, but he points out that Thurnam ("Archæologia," vol. xlii.) speaks only of "a small vessel described as resembling a Roman lachrymatory." It is possible that this may have dropped into the chamber of the barrow from a secondary interment on the summit, the date of which is established by the discovery with the corpse of brass coins of the three sons of Constantine the Great.

MR. R. RIDGWAY is to be congratulated on the issue of the fifth volume of his valuable descriptive catalogue of the birds of North and Middle America (published as Bulletin No. 50 of the U.S. National Museum). This volume brings the subject down to the end of the trogons. The number of species and subspecies (apart from certain extra-limital forms) recorded in the five volumes already published is 2038, leaving from about 1150 to 1200 to come.

BULLETIN No. 101 of the Entomological Section of the U.S. Department of Agriculture is devoted to an account, by Mr. A. F. Burgess, of the elaborate measures taken to introduce and acclimatise in New England the European ground-beetle, *Calosoma sycophanta*, for the purpose of keeping in check the destructive gipsy and brown-tail moths (introduced inadvertently from Europe), on the caterpillars of which these beetles prey. After much trouble, the acclimatisation has been successfully accomplished.

IN the section on marine biology in the Ceylon Administration Reports for 1910–11 and in the January number of *Spolia Zeylanica*, Dr. J. Pearson records the work that has been recently accomplished in connection with the pearl-banks, the windowpane-oyster (Placuna) fishery, and the fresh-water fisheries of the island. For some years past the Placuna beds in Lake Tamblegam have been commercially unprofitable, and a survey of the lake has been accordingly undertaken. This shows that in some parts there are beds of living oysters, while in others only dead shells are to be found, and it is considered that much may be done by transplantation. To make this effective, annual surveys are deemed necessary. Steps are also to be taken for introducing a fresh supply of that valuable food-fish the gurami, as only three survivors of those introduced by Dr. Willey were discovered.

STUDENTS of zoology should welcome the appearance of the third and fourth volumes of the delightful little monographs of indigenous animals prepared by Profs. Ziegler and Woltereck (Leipzig: Verlag von Dr. Werner Klinkhardt). The third volume, by Dr. Otto Steche, deals with Hydra and the Hydroids, and is an altogether admirable account of the freshwater polypes and their marine relatives, including a most useful introduction to experimental biology. The fourth volume is devoted to the edible snail (*Helix pomatia*), which is treated in a very comprehensive and thorough manner. The beautiful coloured frontispieces form one of the most attractive features of these volumes, which are published at four marks each.

ASSUMING the observations to be trustworthy, a most remarkable case of the efforts of an organism to free itself from a parasite has been recently recorded. In 1910 Mr. O. Schröder (*Zeits. wiss. Zool.*, vol. xlvi., p. 525) described and figured, under the name of *Buddenbrockia plumatellae*, a parasite infesting the body-cavity of polyzoans of the genus Plumatella. At the time the parasite was provisionally regarded as a mesozoan. This determination was, however, on the face of it improbable, seeing that the Mesozoa are a marine group, and the author (*Verk. nat.-med. Heidelberg*, N.F., vol. xi., p. 230, 1912) has recently come to the conclusion that the parasite is in all probability a very degenerate nematode. Be this as it may, the interesting point is that after the parasite has become established in the body-cavity of its host some of the spermatozoa of the latter penetrate the eggs of the former, which thereupon swell up and undergo a kind of degenerate development, until they ultimately perish, the polyzoan thus making use of its male generative products as torpedoes to destroy an enemy. Such a mode of repelling a hostile attack appears quite unknown in any other group of organisms.

THE Agricultural Statistics of India for the years 1905–6 to 1909–10 have recently been published at Calcutta by the Department of Revenue and Agriculture of the Government of India. The first volume, a large Blue-book of more than 400 pages, deals with British India; the second, a much smaller one, with the native States. The first section deals with the classification of areas in each district into forest, land not available for cultivation, land culturable but at present waste, and areas cropped; irrigation statistics are also given. In a later section the areas under the various crops are set out. Other sections deal with live stock and implements, incidence of revenue assessment, and transfers of land.

A REMARKABLE instance, caused by a parasitic fungus, of the transformation of the flower into a number of leaf-like organs is described by Mr. S. Kusano in the Journal of the Tokyo Agricultural College (vol. ii., No. 6). The fungus, *Caeoma Makinoi*, infects the young buds of *Prunus Mume*, and causes great malformation of the organs of the flower. In some cases only part of the flower is affected, in others all organs are subjected to more or less complete phyllody. Occasionally flowers of enormous size are produced, which possess not only green leaves brilliantly spotted with the yellow pustules of the fungus, but also leafy shoots. The author describes the phyllody of the different floral organs with great care, and discusses the relation between the development of the fungus and the malformation of the flower. His paper, which concludes with some interesting etiological considerations, forms a valuable contribution to the literature on chloranthy.

IN the *Atti dei Lincei*, xxi., 4, Dr. Diana Bruschi contributes some interesting studies on three fungi parasitic on fruits, namely, *Fusarium lycopeisici* on the tomato, *Movilia cinerea* on the plum, and *Fusarium niveum* on the pumpkin. It is found that the toxic action of the fungi is not proportional to the acidity of the extract produced by them, and disappears to a large extent with cooking. The enzymes secreted do not attack the cellulose, but rather the proteins, of the fruits.

THE list of geological literature added to the library of the Geological Society of London in 1910 was issued at the close of 1911, price 2*s*. As we have previously pointed out, this annual work is practically an index to the geological publications of the world.

THE study of eoliths has assumed such importance that it may not be too late to direct attention to a discussion of the alleged examples of Oligocene age found by A. Rutot on the plateau of Hautes-Fagnes, in Belgium. R. Bonnet and G. Steinmann conclude that they were formed by wave-action in a rapidly advancing sea (*Sitzungsber. vom naturhistor. Verein der preuss. Rheinlande u. Westfalens*, December 6, 1909, pub. 1910). A useful bibliography of some sixty works in French and German on eoliths is appended.

IN *Scientia*, vol. xi. (1912), p. 36, Prof. J. W. Gregory discusses "The Structural and Petrographic Classification of Coast-types" in a manner that will appeal both to geographers and to geologists. He succeeds in showing how difficult it is to maintain Suess's original definitions of the Atlantic and Pacific types of coast in the broad regions from which their names were derived, and he criticises the attempt to connect types of igneous rock with types of tectonic structure.

THE Weather Bureau of the Commonwealth of Australia has issued in the form of a picture postcard an average rainfall map of the Commonwealth, together with a table showing the comparison between the total area of the United Kingdom and the different rainfall areas shown by grades on the rainfall map of Australia. The map was prepared under the direction of Mr. H. A. Hunt, Commonwealth meteorologist.

"THE Value of Non-instrumental Weather Observations" is the title of an interesting article by Prof. R. DeC. Ward in *The Popular Science Monthly* of February. Like some meteorologists in this country, he considers that such observations add greatly to the interest of everyday life, and develop in a surprising way powers of observation which one is unconscious of possessing. In relating his own experiences during a recent period of convalescence, he suggests the study of weather prognostics (comparatively few of which are found to be really good). In emphasising the value of non-instrumental observations, he refers at considerable length to the Journals of the Lewis and Clark expedition to the sources of the Missouri and across the Rocky Mountains in 1804–6, the leader of which was instructed by President Jefferson to report upon the climate according to a scheme drawn up by himself. No more striking illustration of the analogy between the winds of the ocean and those of the plains has been given than Captain Lewis's description of the occasion when one of his boats, which was being transferred on wheels, was blown along, the boat's sails being set. "Both [winds] sweep over a surface of little friction. Both attain high velocities in consequence."

AN illustration of the growing importance of mathematics in the study of social and economic problems is afforded by Dr. L. Amoroso's note in the *Atti dei Lincei*, xxi., 4, entitled "Contributions to the Mathematical Theory of Economic Dynamics." In this system an individual is represented by a point capable of moving in a variety of *n* dimensions, which may represent different forms of wealth, and these are subject to certain equations of condition. From the fundamental premises the author deduces "equations of motion" corresponding to those of analytical dynamics. The first investigations on this branch of study are attributed to Cournot, Jevons, Malras, Edgeworth, Fisher, and, latterly, Pareto.

IN a pamphlet called "Studies in Statistical Representation," reprinted from the Journal of the Royal Society of New South Wales, Mr. G. H. Knibbs discusses the application of Fourier's series to the study of fluctuating statistics. The paper deals mainly with the methods of obtaining the coefficients in such expansions, and of correcting for such irregularities as inequality in the lengths of months or years, variations in the time of Easter, and so forth. The author, as illustrating the method, claims to deduce a relation between the temperature and the number of suicides in Australia, but remarks: "The discussion as to whether this relation can be rationalised is really an extra-mathematical one, and is outside the scope of the present paper." A contribution to the higher mathematics of statistics is contained in Prof. C. V. L. Charlier's recent article in the *Arkiv* *för Matematik* on the theorems of Poisson and Lexis.

According to an article reprinted from the Proceedings of the Academy of Science of Amsterdam, Prof. Zeeman, in the course of some experiments on the double refraction produced in liquid air by an electric field, has found that liquid air will stand an electric field of 90,000 volts per centimetre. In his double refraction measurements a difference of potential of 17,000 volts was maintained between the plates of a condenser 4·5 centimetres long, 1·0 centimetre wide, and 0·3 centimetre apart immersed in liquid air, and a beam of plane polarised homogeneous light traversed the liquid air between the plates. The phase difference introduced by the double refraction due to the electric field was estimated at 1/300 wavelength, so that the Kerr constant for liquid air is about 1/20 of that of carbon bisulphide.

The therapeutic action of certain mineral springs has been recently attributed, at least in part, to the presence of the radium emanation in the water. Experimental evidence in support of this view is given by P. Mesernitsky in the current number of the *Comptes rendus* of the Paris Academy of Sciences. It was found that the radium emanation decomposes sodium urate, some ammonium salts being formed. The exact nature of the decomposition (which was shown to be due to the action of the α rays, the penetrating rays being without effect) has not been completely made out, but there is a marked increase of solubility of the urate. It is suggested by the author that this action of the α rays upon sodium monourate may furnish an explanation of the therapeutic effects of the emanation in gouty cases.

A paper by Mr. Andrea Naccari in vol. xlvii. of the *Atti* of the Academy of Sciences of Turin (December, 1911) takes as its starting point an old memoir by Samuel Hunter Christie in the Phil. Trans. for 1826, entitled "On Magnetic Influence in the Solar Rays." Christie found the amplitude of oscillation of a magnet to decrease more rapidly than usual when sunlight fell on the magnet. The phenomenon had since been studied by Baumgartner, who found that it was not confined to magnets, and concluded that the real cause was air currents set up by the heating. Naccari confirms the view that magnetism has nothing to do with the phenomenon, but he differs from Baumgartner as to the cause. He ascribes it to the effect of radiation on the air which is carried by the oscillating body and that immediately surrounding it. Under certain conditions, the effect of thermal radiation on the damping seems very large, and further study of the phenomenon from the point of view of the kinetic theory of gases might not unlikely prove profitable.

In a paper read at the Concrete Institute on March 14, Mr. Reginald Ryves treated the question of high dams of great length, and proposed a form of thrust buttress dam of arches, in which the whole of the water load is taken by masonry in direct compression, and neither the weight of the buttress nor the weight of the arch is taken into account as regards stability, except for resistance to sliding bodily when the ground is comparatively soft. Under normal conditions, the best slope for the water face is 45°. The dam consists of inclined arches of increasing thickness as the depth increases, and sloping at 45°. The abutments rest against the up-stream faces of the buttresses, which are built of layers all inclined at 45°. Every part of such a dam is subject to the same stress, except that the top layer of the buttress and the upper part of the arch ring may have the minimum in each case for the materials used. The author claims that this type is suitable for heights up to 200 ft. with a stress of 10 tons per square foot, and up to 300 ft. for 16 tons per square foot.

Mr. Edward Stanford has published an excellent, well-coloured geological map of central Europe which will prove of great service to students of geology, and less directly to teachers of geography. The map is $16\frac{3}{4}$ in. by $10\frac{1}{2}$ in., and costs 5*s*.

M. J. Danne asks us to say that his laboratory at Gif for experiments on radio-active substances is about 26 kilometres from Paris, and not 206 kilometres, as stated in last week's Nature (p. 69).

OUR ASTRONOMICAL COLUMN.

Astronomical Occurrences for April:

April 1. 0h. 0m. Neptune stationary.
1. 1h. 0m. Jupiter stationary.
1. 10h. 14m. Moon eclipsed. Visible at Greenwich.
6. 8h. 32m. Jupiter in conjunction with the Moon. (Jupiter 5° 8′ N.).
10. 4h. 54m. Uranus in conjunction with the Moon. (Uranus 4° 46′ N.).
10. 19h. 0m. Neptune at quadrature to the Sun.
15. 0h. 0m. Mercury in inferior conjunction with the Sun.
15. 5h. 17m. Venus in conjunction with the Moon. (Venus 0° 5′ N.).
16. 22h. 51m. Sun eclipsed, partially visible at Greenwich, ends at 1.31 p.m. on April 17.
18. 18h. 31m. Saturn in conjunction with the Moon. (Saturn 4° 47′ S.).
20–22. Lyrid meteors at maximum.
22. 3h. 22m. Mars in conjunction with the Moon. (Mars 3° 25′ S.).
22. 21h. 53m. Neptune in conjunction with the Moon. (Neptune 5° 53′ S.).
23. 10h. 0m. Uranus at quadrature to the Sun.
27. 11h. 53m. Mercury in conjunction with Venus. (Mercury 0° 10′ N.).

The Eclipse of April 17.—In the *Revue générale des Sciences*, the Abbé Moreux publishes an interesting summary concerning the chances of a total eclipse of the sun being observed on April 17 next. He points out that M. Landerer's very slight modifications of the data produced considerable changes in the figures showing the size and path of the shadow cone, but even then the maximum breadth of the latter was only 200 metres (about one-eighth mile).

Adopting the new figures given by Dr. Crommelin, the Abbé Moreux finds that totality will last 1·6s. just before reaching the Portuguese coast, 1·5s. between Penafiel, about twenty miles east from Oporto, and Cavez, and about 1s. as the shadow leaves the northern shore of the Peninsula. He calculates that at St. Germain and Namur the height of the apex of the shadow cone above sea-level will be 30 km. (19 miles) and 52 km. (32½ miles) respectively.

Further, he makes the suggestion that although totality may not yet occur, the corona may be seen, for at previous eclipses it has been seen well before and after totality, and in 1900 was photographed by Mr. Willis eight minutes after.

Finally, he presents the peculiar possibility of there being neither an annular nor a total eclipse; this would occur if the mean apparent diameter of the moon were just insufficient to produce totality, because of the depressions at the limb, yet was so great that the mountains at the moon's limb projected far enough to break up the continuity of the solar limb.

In No. 4562 of the *Astronomische Nachrichten* Dr. Graff also discusses the position of the lunar mountains, and also the possible observations of the lowest levels of the chromosphere. He suggests, finally, that suitably arranged astrophysical observations may not prove so unprofitable as it has been generally supposed they must be in the circumstances of the coming eclipse.

NOVA GEMINORUM NO. 2.—A number of messages concerning observations of Herr Enebo's new star have been received by the Kiel Centralstelle, and are published in No. 4562 of the *Astronomische Nachrichten*.

At Christiania, early on March 13, Prof. Schroeter estimated the magnitude as 4·0, while Dr. Hartwig at Bamberg on March 13, at 10h. 23·9m. (Bamberg M.T.), found it to be 4·3; he gives the colour as reddish, and the position, for 1912·0, as 6h. 49m. 11·87s., +32° 15′ 6″.

On March 14 Prof. Pickering reported that the spectrum of the nova was of the F_5 type, but on March 15 he reported a change to a bright-line spectrum. In the Harvard classification the type F_5G represents spectra similar to that of Procyon, the Procyonian type in the South Kensington classification, which is the next earlier type to the solar stars.

According to Dr. Hartwig, the nova corresponds very closely with a thirteenth-magnitude star on the Palisa-Wolf charts. An observation made at 11.45 p.m. on March 20 showed the magnitude of the nova to be about 5·4.

ANALYSES OF STONE METEORITES.—A valuable contribution to the study of meteorites appears in Publication 151 of the Field Museum of Natural History, where Mr. O. C. Farrington publishes a list of analyses of 125 stone meteorites, and a scheme of classification. An "average" composition, derived from the whole, gives the following substances, and their percentages, as the principal constituents:—SiO_2 (39·12), Al_2O_3 (2·62), FeO (16·13), MgO (22·42), CaO (2·31), Na_2O (0·81), Fe (11·46), Ni (1·15), S (1·98); there are thirteen other constituents.

It is worth noting that this list does not truly represent the relative spectroscopic importance of the various substances in meteorites. In the "Spectroscopic Comparison of Metals present in Certain Terrestrial and Celestial Light Sources," published from the Solar Physics Observatory in 1907, the chief metals were arranged in order of the prominence of their strongest lines in the spectra of the eight or nine stony meteorites examined. The order was as follows:—Cr, Na, Al, Mg, Mn, Si, Ca, Fe, Ti, V, K, Sr, Ni, and Ba.

In the spectra of all the certain meteorites, chromium is very well marked, yet in the chemical analysis given by Mr. Farrington it is only represented by 0·41 per cent. of Cr_2O_3.

OBSERVATIONS OF NOVÆ.—Observations of the magnitude of Nova Lacertæ are published by Prof. Nijland in No. 4562 of the *Astronomische Nachrichten*. Between January 1 and December 15, 1911, the magnitude sank from 7·50 to 11·40, and the plotted values show practically no oscillations of the brightness.

Observations of the suspected Nova 87·1911 Persei, discovered by Mr. D'Esterre, are reported by that observer in the same journal. The later photographs, showing fourteenth-magnitude stars, show, in the position of the nova, a nebulous patch in which appear to be involved three condensations or very faint nebulous stars.

LIFE IN THE OCEAN.[1]

MORE than twenty years have passed away since the veteran physiologist of Kiel—Victor Hensen—initiated a new era in plankton research characterised by the application of biometrical methods. His inventions and investigations culminated in the equipment of an oceanic expedition which was to be an experiment on a large scale. It was one of the first German scientific expeditions, and certainly the first oceanic expedition to be devoted entirely to the study of the floating organisms.

Hensen's pioneer work, with its enormous labour and brilliant negotiation of abstruse problems, was carried out in the face of much unfair criticism—the famous polemic of Haeckel, "Plankton Studien," will long be remembered by the Kiel school.

During the years that have elapsed since, the same kind of destructive criticism has been at times proclaimed, and almost always by those who seem to have taken no trouble to study the work they would demolish.

The material collected by this "plankton" expedition has been examined by specialists, and now, after twenty-two years, Hensen has taken up the pen and written what should be the final volume (1), the last word, were it not that two or three reports still remain unfinished.

The greater part of the volume deals with the quantitative geographical distribution of pelagic organisms in the North Atlantic. Numerous tables are appended, and these, with the reports, complete what must be considered the first scientific attempt to determine the distribution of the plankton of the high seas. The work as a record is of great value. It must be remembered, however, that the studies of recent years have emphasised the remarkable seasonal variations occurring in the plankton of both lakes and seas; hence, the observations of the Humboldt-Stiftung expedition, which lasted but three and a half months, must be regarded as only presenting a phase in the distribution of life in the ocean.

Perhaps the most interesting part of the volume is Hensen's *résumé*, which deals with contemporaneous plankton work and other problems which have been much discussed during the past few years, such as Putter's theory and the theories of de Vries.

The great aim of the plankton expedition was the determination of the actual number of the different organisms in the waters of the high seas. Within certain limits this has been carried out, but on the whole the figures looked at in this light are of little importance. It is the methodical manner in which quantitative nets are used, and the elimination of

[1] (1) "Das Leben in Ozean nach Zählungen seiner Bewohner: Uebersicht und Resultate der quantitativen Untersuchungen." By Prof. V. Hensen. (Ergebnisse der Plankton-Expedition der Humboldt-Stiftung. Bd. v. O.) Pp. v+406+Tabellen (pp. 8+xxviii tables+map.) (Kiel and Leipzig: Lipsius and Fischer, 1911.)

(2) "Ueber das Nannoplankton und die Zentrifugierung kleinster Wasserproben zur Gewinnung desselben in lebenden Zustande." By H. Lohmann. Pp. 38+5 plates. (Leipzig: Dr. Werner Klinkhardt, 1911.)

(3) "Leitfaden der Planktonkunde." By Prof. A. Steuer. Pp. iv+382. (Leipzig and Berlin: B. G. Teubner, 1911.) Price 7 marks.

the personal equation by the enumeration of the organisms, that makes biological work of this kind so valuable. Whatever errors creep into quantitative plankton studies—and no one knows better than the planktologist the inaccuracy of the methods—they occur in a similar way throughout, and affect all calculations to the same extent. The final result is a series of comparable observations, and the possibility of comparison is *the* keynote of quantitative plankton work.

Hensen's treatment of two of his critics does not seem quite fair. Kofoid's objection that the original net lost many of the smallest organisms has been upheld by the work of Lohmann. As for Herdman's work in the Irish Sea, the absence (which he has insisted on) of the uniform distribution of plankton necessary if observations made at stations far apart are to be of any value cannot be denied. Furthermore, it is just in waters like the North Sea and Irish Sea that most naturalists find it possible to work. Whatever may be the cause of the complexities in the Irish Sea, the variations which have been followed by the Port Erin workers have been of such magnitude that no small errors could invalidate the deductions drawn.

The influence of Hensen and his quantitative methods has been greater than at first sight would be imagined. There is no doubt that, as in many other cases, work along quite different lines has been stimulated or even created. Take, for example, the careful analyses of sea water, the study of the distribution of nitrogen, of silica, and hydrographic work in general. There was a continuous demand for very accurate knowledge from those who would explain distribution by the altered environment. It was the plankton expedition itself that startled biologists with the statement that life was more abundant in the Arctic and temperate waters than in the tropics, and out of this has arisen the ingenious attempts to explain the anomaly. Bound up with this is the search for the factors which govern the seasonal changes in the plankton and the detailed researches which have been made on the latter in seas and lakes throughout the world. The question of the food supply of aquatic organisms, now no longer a simple subject, but one bristling with unsolved problems, requires further research along many different lines, particularly chemical and physiological.

Finally, the systematist who follows the individual organisms, counting as they pass across the field of view, recognises the variations in shape and size, and hesitates before coining new species (especially if working through a year's catches). In fact, for the study of evolution we need to go to the simplest organisms existing under the most simple conditions of environment. For this purpose there is a wide field open for research in the plankton of warm waters. Hensen shows that the seasonal variations, which complicate so much plankton studies in our waters, are to a great extent absent in the tropics. It is probably the seasonal variations which are at the bottom of many strange features of distribution round our islands. It would be quite impossible to touch on the numerous points of interest (many of which should create discussion) in a short article. Victor Hensen must be congratulated upon the conclusion of a work to which he has given so much of an active life.

(2) Two other works which have recently been published may very conveniently be discussed here. The first deals entirely with those small organisms which pass through the finest tissue of which plankton nets are made.

Lohmann has proved himself to be one of the foremost plankton workers in the world, and it is to this man of science that we owe our knowledge of the limitations of Hensen's methods. Thus the methods of the Kiel school have received their critical tests at the hands of the Kiel school. Lohmann proposes to use the term "nannoplankton" for the very small organisms, both animal and vegetable, of the pelagic world.

At the present time Schütt's terms, macro-, meso-, and mikro-plankton, are usually employed. No exact definitions of these groups were ever given, but the macroplankton was understood to include such organisms as medusæ, whilst the rest of the plankton in a net catch belonged to the groups, meso- and mikroplankton. The former of these two divisions included the copepoda, worms, &c., and the protozoa and protophyta made up the second. To these three terms Lohmann adds two others: the "megaloplankton," for all large organisms visible from a ship's deck and varying in size from centimetres to metres, and the nannoplankton for the most minute forms.

Naturally, different apparatus is required for the collection of the nannoplankton, and the net has been supplanted by the centrifuge. Water can be bottled at any depth, and it has been found that quite small quantities suffice.

It must be remembered that though the actual volume of the nannoplankton is small, the degree of importance depends on the rapidity of multiplication and the duration of life of the organisms of this group, and in this respect their absence from the net catches of the plankton expedition is much to be deplored.

(3) The other work to be mentioned differs entirely from the above in being a text-book, and there can be no doubt whatever that such a book is necessary to-day in consequence of the great extension of plankton work during the last few years. This volume gives a detailed and fair description of all the methods employed, with the results of recent researches in seas, lakes, and rivers.

Its greatest value will be perhaps to those biologists and general scientific workers who wish to obtain information about this branch of biological science without wading through the vast number of small papers which have been already published. Prof. Steuer is to be congratulated on the very able way he has brought so many different lines of work together, and the volume ought to find a place waiting for it in most university libraries. W. J. DAKIN.

UNIVERSITY REFORM IN NEW ZEALAND.

IT may be taken for granted that all universities are not built on the same pattern; that local conditions and the requirements of the population have to be taken into consideration. The American and German universities, with their plans of government and conditions of study, meet the requirements of the respective peoples; Oxford and Cambridge, with features in common with one another, differ widely from the rest of the British universities in many respects. The type of the Scotch universities is unlike that of the modern English institutions, such as Liverpool and Manchester, while that of London is organised in a fashion peculiar to itself.

It is not to be wondered at, therefore, that the University of New Zealand should present anomalies in its constitution; the peculiarly isolated position of the country, the great difficulties of communication between its chief towns, especially in early days; the paucity of university men both on the staffs of the colleges and outside their walls at the period of its foundation; the local prejudices, amounting almost to jealousies, which existed between the provinces into which the colony was once divided—these and other local conditions have led to a unique relation between the four university colleges and the University itself. The latter is governed by a Senate largely consisting of laymen without any connection with teaching, though a proportion of its members are professors at the colleges. Each of the colleges is governed by a council, on which, in three of the colleges, professors have no seat; while the professorial board in each deals with the real academic work of its college.

The constitution of the Senate and college councils is open to criticism, and it is felt in some quarters that the professors have not sufficient representation on these bodies.

But perhaps the most curious feature of the University is to be found in the method of granting degrees in arts, science, and laws. The University is purely an examining body; by it the examiners are appointed, and these examiners, eminent men in their subjects, are resident in Britain. They set the papers, to them the candidates' answers are transmitted, and their reports are sent out to New Zealand. Everyone agrees that this method is cumbrous, entailing much delay and inconvenience to candidates; while the professors at the colleges have no direct share in examining for the degrees. In early days, no doubt, various causes led to some such arrangement; but it is felt by some of the younger members of the professorial staff, fresh from English universities, with totally different traditions and local conditions, that the time is ripe for some change.

Hence has arisen a Reform Association, the executive of which has issued a booklet of some 200 pages,[1] dealing fully, and on the whole impartially, with the various grievances complained of, viz.: the organisation of the University; appointments to chairs in the colleges; finance; examinations; libraries; research; with suggestions for reorganisation; followed by an appendix containing the opinions of a large number of professors, British and American, on the questions of external examinations and the constitution of the governing bodies.

Many of the grievances are domestic in character, such as libraries, laboratories, appointment of professors, and can only be dealt with by the individual colleges; and it is all a matter of money; but there are one or two points of wider importance which may be discussed here.

It is within our knowledge that the originators of this reform movement are members of Victoria College, Wellington, and that the entire staff even of that college is not wholly in sympathy; nor can it be said that the staffs of the other three colleges are in complete accord with the views of the reformers. This is partly due to the failure of the originators to consult the professorial boards officially or to discuss with the older members of these boards the plans for reform advocated: so that the pamphlet must not be taken as expressing the views of the whole body of university teachers in New Zealand. There is no doubt room for reforms, though it appears to us that some of the grievances about the constitution of the Senate, for instance, are exaggerated. We may remind the reformers that even in the ancient universities of Oxford and Cambridge the final body court of appeal, Convocation, consists "of a fortuitous concourse of members who happen to be able and willing both to pay for keeping their names on the books and to be present in Oxford on a particular day"—to vote for or against reform. The majority of these men are "laymen" so far as university teaching is concerned; and it is interesting to note that the teachers and active members of the University of Oxford are hampered as much as—nay, more than—the teachers in New Zealand, in their efforts for reform.

As a matter of fact, in New Zealand, if the four teachers of a given subject are unanimous in desiring any alteration in the syllabus of their subject, the Senate invariably adopts their proposals. Even the appointment of the examiners is virtually in the hands of the teachers, for if the four professors of a given subject send up a recommendation to the Senate, it is acted on; but, of course, if no suggestion is made, the Senate has to make the appointment. Again, the professorial boards of the four colleges are consulted on nearly every point of importance before the matter is dealt with in Senate. It is true that more frequent conferences between these boards are desirable, and if annual conferences were arranged, many reforms would probably be introduced.

But the chief need seems to be an alteration in the present system of examination for degrees. We need not here discuss the advantages that have been claimed for this procedure—the uniformity and impartiality of the examinations; the maintenance of a standard and stimulation of the teachers; and the enhancement of the value of the degree—these are dealt with fully in the report, and it is claimed that the disadvantages outweigh these supposed advantages. The system is unanimously condemned by the British professors who have replied to the questions submitted to them.[2] The majority of the gentlemen whose replies are recorded have no acquaintance with the geographical conditions of the Dominion, nor is it clear whether the examinations for honours and scholarships were in their minds; we think that, in the case of these competitive examinations between men from different colleges, an external examiner is necessary, if only in justice to teacher and student. The discussion refers to pass examinations only.

But while it is easy enough to see the faults of the system, it is not quite so easy to substitute a new plan, as may be seen in the varied proposals submitted.

Three alternatives have been suggested:—

(1) That each of the four colleges should be an independent university. In theory, no doubt, this seems plausible; but when we remember that the highest number of students at any college is about 400 (and in others much less) and the total population of the Dominion only about one million, it does not seem desirable at present to have four different standards for the degrees in arts and science. For it must be borne in mind that while most of the professors have had a training in a British university, there are some who do excellent work indeed, but who have no experience of any higher standard of work than that at their own small college in New Zealand; and, especially in the case of science, this is detrimental. It is agreed that the present standard for the degree is a low one, at any rate in several subjects, and one understands that this must be the case when matriculation can be passed by children of fourteen years of age, and the entrance scholarship, for which the schools prepare, is almost of the same standard as the B.A.

[1] "University Reform in New Zealand." Published by the General Editors (Profs Hunter, Laby, and von Zedlitz) under the direction of the University Reform Association. Pp. 196. (Wellington, N.Z., and London: Whitcombe and Tombs, Ltd., 1911.)

[2] Though the opinions of acting professors in New Zealand are not included, those of six past professors or graduates of New Zealand are recorded; it is noteworthy, however, that Prof. Rutherford, whose views would be valuable, offers no comments on the system. Each of these six men gives an opinion more or less different from the other five, and amongst them may be found all the various possible plans for degree examinations and for reorganisation.

(2) A second proposal is that the teachers of a subject at the four colleges should form a board of examiners—either four (or only two) to constitute the board. Presumably each member would set a portion of the papers; in this case, if the four men act, the students at each college would recognise the "pet" questions of their teacher, which, although forming only a portion of the paper, would receive fuller answers than the rest of the paper, and this would mean, practically, that each college would be holding its own examination. Consequently the result would be essentially the same as in the first case. Moreover, the suggestion that all four teachers should cooperate is not quite so feasible as would appear; they would, of course, have to meet on several occasions, and though it is easy enough for a man in Edinburgh or Glasgow to run up to London in a few hours to confer with his co-examiner, yet the geography of New Zealand renders travelling less easy. Auckland and Dunedin are separated by nearly 900 miles, and this journey occupies at least sixty hours. It would be very inconvenient, to say the least, for these two men to spare time to meet, even at a midway point, while the cost to the University of such a scheme would be very heavy. Moreover, details of procedure would be far from easy to arrange.

(3) The purely external system of examination is condemned by most authorities. The real feature of the grievance lies not so much in having the examination for degrees conducted by external examiners in Britain or elsewhere, as in the total exclusion of the teachers from this examination; and it seems to us that the best suggestion is one made by two or three of those consulted, viz. that the teacher of a subject should make a report on each student, which would be forwarded to the examiner, who would take it into consideration in his award. For it is manifestly unjust to a candidate who has worked well throughout the year to be judged only by his answers to a paper, written on a day on which he may be unwell or otherwise unfit.

Every student, before presenting himself for the degree examination, has at present to pass an examination held by his teacher, and in the case of science a practical examination in addition must be done to his satisfaction. The marks awarded in these, if sent to the external examiner, would influence him in his award.

Indeed, it happened on one occasion that the degree had to be awarded entirely on these college examinations, for the ship conveying to England the candidates' answers was wrecked, and all the papers lost.

The reformers cavil at the small encouragement the university colleges give to research, while, as the pamphlet points out, there is opportunity but for a limited amount of original investigation. They rightly complain of the bugbear of examination if it be regarded as the "be-all and end-all" of university training; but, since the examination is part of the British system precedent to obtaining a degree, it is hopeless for a small colony like New Zealand to attempt to eradicate this evil so long as the Mother Country adheres to it.

In New Zealand there is no leisured class who can afford to spend time in pursuing knowledge for its own sake, and the degree is chiefly required by those entering the teaching profession, who must have a fairly all-round training in subjects useful for their purpose.

To such men and women specialisation at an early stage in the university career would be fatal to their prospects; there is no demand for specialists in chemistry or physics or biology, and it would be a cruel thing to encourage a man to spend two or three years in research, with no available opening at the end. Moreover, the libraries and staffing of the colleges are insufficient, as the reformers emphasise, for extensive research, which is best left to the later stages of a man's career, viz. for honours. What sort of research can a student in New Zealand pursue in languages?

It seems clear, however, that certain reforms are needed, but we fear that the reformers must not expect that all their grievances will be rectified immediately.

EXPERIMENTAL ERROR IN AGRICULTURAL INVESTIGATIONS.[1]

IN view of the large number of agricultural experiments carried out in the country it is very desirable that some attempt should be made to put them on a sound basis, so that the results shall have some permanent value and admit of definite interpretation. The experiments cost a good deal of money, practically all of which is found by public bodies, and the work is frequently carried out without any particular regard to scientific method.

Perhaps the most serious defect hitherto has been the ignoring of experimental errors, so that only in very few cases could the experimenter say what degree of accuracy he had obtained or what was the significance of the differences he observed. In order to provide a remedy a day was devoted to the subject at the agricultural subsection to the British Association in 1910, and some of the papers then read have been amplified, and are now issued as a supplement to *The Journal of the Board of Agriculture.*

They are all couched in simple language, and bring home the fact that the value of an experiment depends on the degree of confidence that can be attached to the result. The opening paper, by Messrs. Hall and Russell, deals with field trials, and the general conclusion is reached that the probable error attaching to a single experiment is at least ± 10 per cent. It is possible to reduce the error to about ± 2 per cent. by repeating the experiment simultaneously on a number of plots, which need not be more than 1/50th acre in extent.

The second paper, by Prof. Wood, discusses analytical results, the sampling of crops, field trials, and feeding experiments, and contains frequency curves and tables of odds, setting out the least significant differences in these usual conditions of the various classes of determinations. The agricultural experimentalist will do well to submit his figures to the simple tests suggested here.

Mr. Pickering deals with experimental errors in horticultural work, which are fairly considerable, and commonly ignored. The experiments and their interpretation are more difficult than in purely agricultural work, and according to the quantity estimated may vary from ± 16 to ± 20 per cent. for a single tree, or from ± 6 to ± 8 per cent. for a set of six trees.

Milk investigations are discussed by Mr. Collins. An ordinary fat analysis is shown to be liable to an error of $\pm 0{\cdot}03$ per cent., while the error in the solids-not-fat determination can be reduced to 0·05 per cent., but may be higher.

The Board of Agriculture has undoubtedly rendered very useful service by issuing these papers in so cheap a form, and it is to be hoped that they will be used as extensively as the importance of the subject warrants.

1 Supplement No. 7 to the Journal of the Board of Agriculture, 1911.

COPPER AND ITS ALLOYS IN EARLY TIMES.[1]

WITH the discovery of metals, and notably the application of copper and its alloys in Neolithic times, we have one of the great turning points, if not the greatest, in the history of human development, the first-birth of the germs of that civilisation and culture to which we have attained at the present day. The discoveries of the properties of steam and electricity and their applications to our industries and other practical purposes of life we are apt to regard as wonderful and epoch-making, yet when we compare them with the results which have followed the discovery of metals, they are but trifling and insignificant.

The order in which the metals were discovered was not the same for every region, as their ores are very capriciously distributed in the world, and it is extremely probable, if not absolutely certain, that the metals which occur native, *i.e.* those which occur as metals in nature, must have been first known to the men inhabiting the localities in which they occurred. The metals so occurring most frequently are gold and copper. The former is much more widely distributed than the latter, and must have been the first metal to be known in many regions.

It is, however, one of the most worthless metals for practical purposes, so that until the rise of Greek and Roman civilisation but little use was made of it. Copper, too, we only find in use to a very limited extent, as it was not well suited for the construction of weapons or useful implements. On the other hand, its alloy with tin afforded a metal which in many physical properties could only be surpassed by iron or steel. According to the views of several ancient writers, Lucretius and Poseidonius, so momentous a discovery as that of metals contained in ores must needs have been brought about by no uncommon cause.

According to them a conflagration consumed forests which covered the outcrop of metalliferous veins, reducing the metals and bringing them to the notice of man, but there are no grounds for such inference. The discovery of metals other than "native" had no such poetic origin, but was brought about in a more commonplace and more humble way. It had its origin in the domestic fires of the Neolithic age.

The extraction of the common metals from their ores does not require the elaborate furnaces and complicated processes of our own days, as pieces of ore, either copper carbonate or oxide, cassiterite, cerusite, or mixtures of these, and even iron oxides which by chance formed part of the ring of stones enclosing the domestic fire, and became accidentally embedded in its embers, would become reduced to metal. The camp fire was, in fact, the first metallurgical furnace, and from it, by successive modifications, the huge furnaces of the present day have been gradually evolved.

First, a shallow cavity would be formed in the hearth of the fire for the reception of the molten metal, and this would be made larger as time went on and larger quantities of metal were required by deepening it or by surrounding it with a higher wall of stones. Furnaces of precisely this primitive form survived in Derbyshire up to the seventeenth century. In Japan the furnace for smelting copper, tin, and lead ores, a mere hole in the ground, which was in universal use there up to 1858, and is still extensively employed, is as simple and rude as that of the men of the Bronze age.

The alloys of copper and tin during the early Metal age, and even somewhat later, were obtained not by melting together copper and metallic tin, but by the reduction of oxidised copper ores containing tin-stone, or of copper ores to which tin-stone was added. As it has been stated by several Continental archæologists that when a copper ore containing tin ore is smelted the tin does not enter into combination with the copper, but passes into the slag, I have made several experiments under the conditions which were available to prehistoric man, which completely disprove their statements.

A furnace of the simplest form, merely a hole in the ground, was constructed in my laboratory at the Royal School of Mines. The fuel used was charcoal. A mixture of copper ore (green carbonate) and tin-stone was smelted in it, and a copper-tin alloy, a bronze containing 22·0 per cent. of tin, was obtained. The experiment was repeated several times, and in every case copper-tin alloys were obtained. This experiment proves indisputably that when a copper ore containing tin ore was smelted by primitive man, a bronze consisting of copper and tin was the result.

The shape and structure of the lumps of copper which have been found in the founders' hoards[2] of the Bronze age afford valuable evidence as to the size of the rude smelting furnaces, the method of smelting, and the manner in which the metal was removed from the hearth. These lumps are always fragments of rudely disc-shaped cakes of about 8 in. to 10 in. in diameter, and 1½ in. in thickness, having the largely columnar fracture of copper when broken near its solidifying point. They show that the furnace was simply a small shallow hole or hearth scooped in the ground, about 10 or 12 in. in diameter, and that the operation of smelting must have been conducted as follows:—A small charcoal fire was first made in the hearth, and when this was burning freely a layer of ore was spread over it, and upon this a layer of charcoal, then alternate layers of ore and charcoal were added in sufficient quantity to yield a cake of copper. The fire was doubtless urged by the wind alone in the earliest times, but later by some kind of bellows.

When all the charge had melted, the unburnt charcoal and the slag were raked off. The metal was not laded out, but was allowed to solidify first, and at the moment of solidification was rapidly pulled out and the cake broken up at once on a large stone. In Korea, at the copper mine of Kapsan, this primitive method of removing the copper from the furnace still survived when I travelled through the country in 1884.

The method of smelting copper ores in the primitive furnace which has survived in Japan from prehistoric times closely resembles that of the Bronze age. The copper of the Bronze age resembles modern blister copper in composition, but, unlike it, it often contains only traces of sulphur. When sulphur is present in the crude metal only in traces it undoubtedly indicates that the metal had been obtained by smelting oxidised ores. The percentage of copper in several characteristic specimens ranges from about 97·0 to 99·0.

I will now ask for your attention to the earliest alloys of copper and tin, those of the Bronze age. In the production of these alloys in the earliest part of the age, copper ores containing cassiterite can alone have been used; it is obvious, therefore, that

[1] Abridged from the Presidential Address to the Institute of Metals by Prof. William Gowland, F.R.S.

[2] Founders' hoards, many of which have been unearthed in this country and in Europe, contain generally worn out or broken implements, waste castings, and rough lumps of copper apparently brought together for recasting. In some the objects are new and ready for use or are in an unfinished state. They appear to have been the stock-in-trade of itinerant founders. A flat axe made of the alloy is in the British Museum.

the percentage of tin they contain must have varied with the percentage of cassiterite in the ore and the regularity with which the smelting operations were performed. Even in the later period of the Bronze age, when the alloys were made by smelting the copper ore with cassiterite, alloys of definite composition can only have been accidentally obtained. Further, it is very questionable whether the metal tin was ever employed in making the alloys until the Iron age was well advanced, as this metal has never been found in the founders' hoards. Consequently the implements and weapons are of very varied composition, at first generally containing but little tin, less than 3 per cent., but later having that metal frequently in satisfactory proportions for the uses they were intended for.

A curious feature of the alloys of which the early weapons were made in Hungary is the presence of antimony as an important constituent instead of tin. This doubtless arose from the alloys having been prepared by smelting the antimonial copper ores which occur in that country. Axes made of these alloys would be fairly serviceable on account of the hardness produced by antimony in copper. We hence find them in use, with antimony largely replacing tin, until late in the Bronze age.

The difficulties the earliest men had to contend with were extremely great, for it is self-evident that alloys of definite composition could not be ensured by the early practice of smelting mixtures of ores. It would seem, therefore, that when we find weapons or implements of suitable composition for their intended use, some physical tests must have been applied to the furnace product before it had been used for their manufacture.

We will now pass to a brief consideration of the methods followed by prehistoric man for the manufacture of his weapons and implements. Practically all copper celts were cast in open moulds, as if cast in closed moulds they would be more or less vesicular and worthless, except when the copper contained arsenic, tin, antimony, zinc, or nickel in not less proportions than 1 per cent., or an excess of cuprous oxide. The remains of his appliances which have been found show clearly that the metal from the smelting operation was remelted in crucibles and poured from them into moulds of clay or stone, perhaps of sand, but of this there is no definite evidence. The metal was not laded from the smelting furnace, as the small crucibles with rude handles which have occasionally been found, and have been erroneously supposed to be ladles, show no signs of having been exposed to a high temperature both on the inside and outside, as would have been the case had they been so used; the interior and upper edges alone bear marks of such exposure. The reason for this will be seen later.

Implements and weapons of bronze, unlike those of copper, were always cast in closed moulds. The method of melting the metal in each case was as follows:—The furnace or hearth was merely a shallow depression in the ground. The crucibles were made of clay, which was sometimes mixed with finely cut straw or grass. They were embedded in the ashes at the bottom of the hearth in such a manner that their bases and sides were thoroughly protected from the intense heat of the fire, their upper edges and interior only being exposed. This method had been adopted owing to the fusible character of the clay of which they were made. The fuel used was wood and the charcoal which was produced during the process.

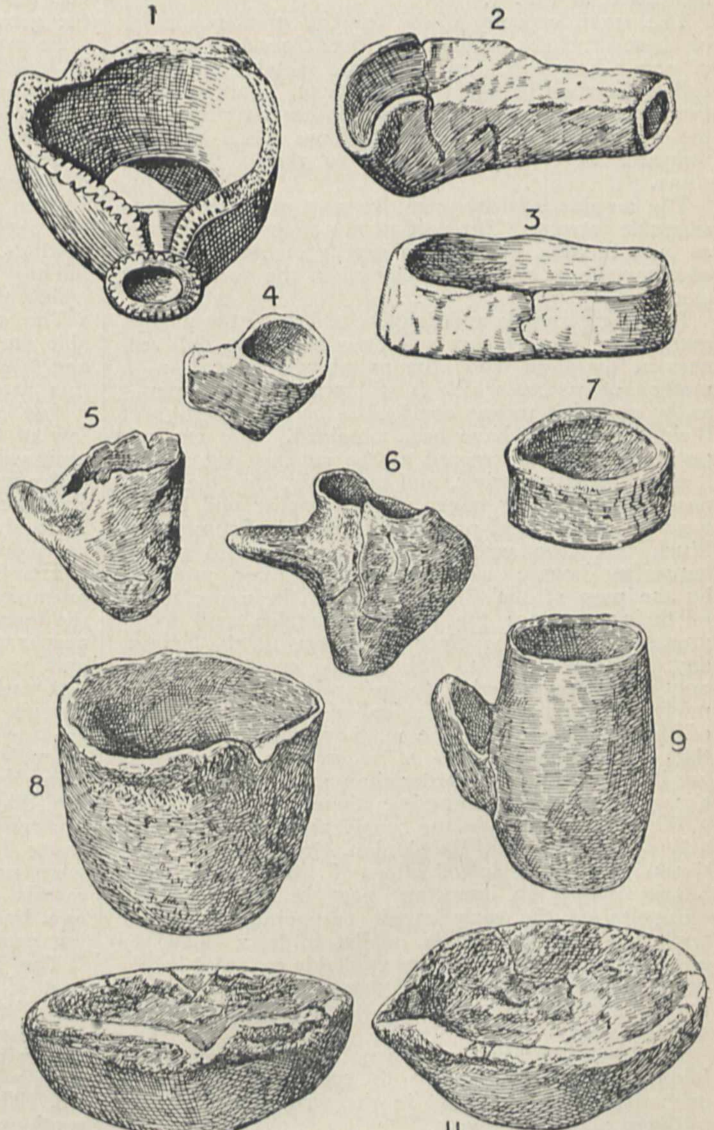

FIG. 1.—Prehistoric crucibles.—1. Clay vessel found among the débris of pile dwellings in Carniola. It is open to doubt whether this is a crucible or not. 2. A common form widely distributed in the remains representing the early Bronze age in the pile dwellings of Switzerland, the Danubian basin, and Ireland. It is furnished with a socket for the insertion of a stick, by which it was removed from the fire and its contents poured into a mould. 3. A shallow oval dish of somewhat rare occurrence, found in the Mond See. 4 Found in the remains of a crannog in Lough Mourne, Ireland. 5, 6, 7, 8, 9. Crucibles found at Dunadd, Argyll, together with iron spear-heads and other iron objects. 10 and 11 were found together with copper and bronze implements and stone moulds in Mercia and Almeria, in the south-east of Spain.

After a crucible had been thus placed and charged with copper, copper and tin-stone, or copper and tin, the fire was made up over it. A sufficiently high temperature for melting the metal could be obtained by the wind alone. When the contents of the crucible had melted, the crucible was removed from the furnace and the metal poured into a mould.

In consequence of this mode of heating, the lower parts of the crucible will, it is evident, bear but little traces of the action of a high temperature, whilst the upper edges and interior will exhibit a fused or semi-fused structure, and this is precisely what we find in all early crucibles.

Some of the most important types of crucibles are illustrated in Fig. 1.

The small capacity of by far the greater number of these crucibles which have been found is worthy of note. Few can have held more metal than would suffice for the casting of a single axe. This is, however, not surprising if we remember that they are the appliances of that remote time when metallic weapons were only beginning to replace those of stone.

The moulds used by primitive man are also of considerable interest. The earliest are of the class known as open moulds, and consist merely of cavities of the necessary form and size hollowed in the surface of a stone.

In casting swords and daggers of bronze the moulds must have been of clay and been heated to dull redness at the time when the metal was poured in—a method of casting which is still practised in Japan—as by no other means could such perfect castings of their thin blades have been obtained. The castings generally were hammered at the cutting edges, and it is to this hammering, and to it only, that the hardness of the cutting edges of both copper and bronze weapons is due, and not to any method of tempering. Much has been written about the so-called art of tempering bronze supposed to have been practised by the men of the Bronze age in the manufacture of their weapons; the hardness is also said to be greater than can be given to bronze at the present day. I should like to correct this error, as it can only have arisen owing to its authors never having made any comparative practical tests of the hardness of bronze. Had they done so, they would have found that the ordinary bronze of to-day can be made as hard as any, in fact, harder than most, of prehistoric times, by simple hammering alone.

We will now pass to the consideration of the copper alloys of Mycenæan, Babylonian, Greek, and Roman times. Until the introduction of iron, copper and bronze played an important part in the lives and struggles of the early races occupying the Greek peninsula and its islands, whilst in later times the alloy bronze afforded an imperishable material to the great sculptors of the golden age of Greece, by which many of their incomparable works have been preserved to us.

In Greek literature we have no records of metallurgical processes relating to copper or its alloys, such as are to be found in the writings of Roman authors, notably Pliny.

Strabo, the only Greek author who condescends to take any notice of metallurgy or metal working, confines his statements to gold, silver, and lead. But at Laurion the remains of ancient furnaces for smelting lead ores, which have been unearthed from time to time, indicate that low hearths resembling those of the Bronze age were extensively employed; and if we may reason from Japanese metallurgical procedure, similar furnaces would be used for copper. The island of Cyprus, once rich in copper ores, was doubtless the source whence the inhabitants of the Greek peninsula in early times obtained their copper.

Among the earliest specimens of the metal which have been found in Greece are some copper nails which were obtained by Dr. Schliemann at Orchomenos, a city in Bœotia, which was in a state of decay in the time of Homer. They belong to that remote period in Mediterranean civilisation to which the name Mycenæan has been applied.

They are interesting as showing that the men of that remote period were able to produce copper of tolerable purity, but this would not be difficult, as the ores which they worked would be oxidised ores, oxides, and carbonates from the outcrops of veins, viz. the parts which were exposed at the surface of the ground.

Bronze was also then in use for nails and cramps in building construction, but especially for weapons, and was of good quality.

There is abundant evidence to show that Egypt was the first in the field in artistic bronze casting. When it first began it is difficult to say, but objects of at least as early as 3000 B.C. are in existence.

Even in the early examples great technical skill is displayed. The most ancient Greek bronzes are solid castings, whereas in Egypt they are light and hollow, having been cast with a core of argillaceous sand, which still remains in many specimens.

The statuary bronze frequently contains considerable amounts of lead, sometimes with but little tin, and the question naturally suggests itself, whether this arose from scarcity of the latter metal. Only a few analyses have been made, and unfortunately few of the objects can have even approximate dates assigned to them.

Bronze was in extensive use in Nineveh about 1000 B.C. for vessels and utensils of many kinds, and curiously was sometimes employed for those which we should now make of more precious metals.

The Greek copper alloys of a later period, many examples of which are found in the coins of about the fourth century B.C., are true bronzes consisting of copper and tin, with lead or zinc only as impurities and not intentionally added.

A curious feature in them is the presence of nickel varying from traces up to 0·5 per cent. The percentage of tin is somewhat irregular, but in most examples ranges from about 8 to 11 per cent. The same is true of the Macedonian coinage alloys from the third to the second century B.C., but the percentage of tin in them is somewhat greater, generally being from about 10 to 12 per cent. These alloys were undoubtedly made by melting together the metals copper and tin, and not, as in the Bronze age, by smelting stanniferous copper ores, or by melting copper with tin ore.

The Macedonian alloys more particularly are the best of the ancient bronzes.

A little later in Greek coins we find lead as an intentional constituent in various proportions, ranging generally from about 6 to 10 per cent., or even more, with a proportionate reduction in the percentage of tin. The Macedonian coins, however, with few exceptions, preserve their character as true bronzes.

The alloys used for statues are frequently true bronze with 9 to 11 per cent. of tin, but in other examples about 5 per cent. of lead has been added, probably with the intention of increasing the fusibility of the alloy and its fluidity when molten.

The statements of Pliny as to the composition and mode of manufacture of the bronzes as imitated in Rome throw but little or no light on the subject; in fact, they are for the most part useless and misleading. As regards the Corinthian bronze, the beauty of which is so extolled by classical writers, he states that the alloy was discovered by the Romans at the sack of Corinth, when vessels of gold, silver, and bronze had been accidentally melted together during the burning of the city and produced a golden bronze.

The siege of Corinth, however, occurred in 146 B.C., but the excellence of Corinthian bronze had been recognised long before.

Whatever may have been the exact composition of this bronze, of which several statues are said to have been cast, I may say that no addition of gold or silver to any copper-tin alloy will cause it to resemble gold closely. Imagination must, I think, be responsible for the accounts given of this bronze by ancient authors, especially when we read also that its beauty was derived from being cooled in the water of the fountain of Peirene.

With the fall of Greece and the rise of the supremacy of Rome we enter an important period in the history of copper and its alloys. In Spain and in Britain we find copper-smelting being vigorously carried on by the Romans, and in Rome and the chief seats of the empire a further extension of the use of bronze, not only for statues and other objects of art, but for vessels of all kinds, furniture, and other articles of domestic life. Of special importance is the invention of a new alloy, brass, which comes into use for the first time in Europe.

Among the varied remains which are representative of the Roman occupation of Britain, few are of greater interest to the metallurgist than the cakes of copper found in North Wales and Anglesea. These cakes afford us, in their form and character, unmistakable evidence of their history. They had been obtained by smelting sulphide ores, or ores containing sulphides, in low hearths, in which they had almost certainly been allowed to solidify before removal. According to Pliny, who seems in this matter to have had access to fairly trustworthy sources of information, the copper obtained by smelting was brittle and useless, and in order to obtain malleable metal from it, it was mixed with lead and melted several times, and the oftener the operation was repeated the better was the quality of the copper. This brief account of copper-refining by a non-technical writer gives us an excellent *résumé* of the process as practised in Roman times. The operation was evidently conducted with free access of air, and the lead used would, by its oxidation, aid greatly in the removal of impurities from the copper.

The earliest Roman alloys which have come down to us are copper, lead, tin, alloys of the fifth century B.C. Their chief peculiarity is their very large content of lead, namely, from about 19 to 25 per cent., the tin being about 7 per cent. They were worthless for practical purposes, but formed the alloy of which the large coin of the republic—which weighed from 8 to 11 ozs.—the "As," was cast. These copper-lead-tin alloys continued in use as coinage alloys until 20 B.C., but from that date until two centuries later lead is seldom found in coins except as an accidental impurity.

The large percentages of lead were undoubtedly added in these cases on account of the cheapness of the metal as compared with copper and tin.

The copper-tin-lead bronzes appear also to have been used by the Romans for engineering and industrial purposes. An interesting example of this use is afforded by the broken shaft of a water-wheel which was found in the lower Roman workings of the north lode of the Rio Tinto mine. The water-wheel was probably built in the first century of our era, as coins of the time of Vespasian (70 to 81 A.D.) were found near it.

The bronze used for statues by the Romans also always contains lead in considerable proportions, as much as 6 to 12 per cent. being often present. In this they were doubtless influenced by Greek practice, the lead being added to the bronze to increase its fusibility and more especially its fluidity when molten, so that it might receive the sharpest possible impressions of the mould.

I may point out here that the addition of lead to bronze was and is largely practised by the Japanese, not only for the reasons stated above, but also to enable the objects cast of the alloy to receive a rich brown patina when suitably treated; and in this connection it is worthy of note that Pliny states that by the addition of lead to Cyprian copper, the purple tint is produced that we see in the drapery of statues.

The alloy used by the Romans for mirrors does not differ greatly from that in use in Europe for metallic mirrors in comparatively recent times, the percentage of tin ranging from 23 to 28 per cent., but lead is present in all from about 5 to 7 per cent.

COPPER-ZINC ALLOYS—THE BRASSES.

Zinc as a distinct metal was unknown in early times; in fact, as late as the sixteenth century it was not known in Europe; but there are strong reasons for the belief that the Chinese were acquainted with it as metal at least several centuries earlier. It is occasionally but rarely present in the implements and weapons of the Bronze age, and then only in small quantities as an accidental impurity, which has been derived from smelting copper ores containing it.

In somewhat later times it occurs in rings, armlets, and other personal ornaments found in the ancient burial mounds of Germany and Denmark, but these mounds are of post-Roman date, and the objects mentioned have really been made from Roman coins.

In Greek alloys zinc is never found as an intentional addition, but only as an impurity, about 1 to 2 per cent. or less; in fact, according to Gobel, all antique objects which contain zinc are not Greek; but this, in my opinion, is only true for those containing considerable proportions of the metal, and not for those with the small amounts just mentioned.

In Roman times it first appears in the coins of the republic as an impurity; as an intentional addition, however, it only begins in the time of Augustus (20 B.C. to 14 A.D.), when brass was made for the first time in the world's history.

One of the earliest examples is a coin of 20 B.C., which contains 17·31 per cent. of zinc.

The Romans were the first makers of brass. Although they were unacquainted with the essential constituent zinc, yet they had discovered that by melting copper together with a certain ore (calamine), a yellow alloy of a more golden colour than bronze could be obtained.

It was first employed for coins which appear to have had a higher value than those of bronze, even up to the time of Diocletian (286 to 305 A.D.), when six parts of brass are said to have been worth eight parts of copper. There is, too, a curious statement by Procopius in his *De Œdificiis* relating to its value in the fifth century A.D., in which he says that brass was then not very greatly inferior to silver.

The method employed by the Romans in making this alloy from copper and calamine was a very simple one.

It was conducted as follows:—The calamine was ground and mixed in suitable proportions with charcoal and copper in granules or small fragments. This mixture was placed in a crucible, and was very carefully heated for some time to a temperature sufficient to reduce the zinc in the ore to the metallic state, but not to melt the copper. The zinc being volatile, its vapour permeated the fragments of copper, converting them into brass. The temperature was then raised, when the brass melted, and was poured out of the crucible into moulds.

This process was so effective that, until a comparatively recent period, all brass was made in Europe by the ancient process, and even until a few years before 1861 it was thus made at Pemberton's Works in Birmingham. It was called "calamine brass," and was generally believed to be superior in mechanical properties to brass made by using metallic zinc.

The survival of this ancient process affords a striking example of the conservatism characteristic of British metallurgy, as brass had been made in England by Emerson, using metallic zinc, in 1781. This, so far as I have been able to ascertain, was the first to be made in Europe by melting copper and zinc together.

In Roman alloys the percentage of zinc was very variable, ranging from about 11 to 28 per cent. For ornamental purposes and scale armour they had an excellent alloy, of which the following are examples. Several rosettes and studs which had formed the mounts of a casket were unearthed in the excavations at the Roman city of Silchester in 1900.

Both the rosette and stud are of practically the same alloy. Now, of all the copper-zinc alloys, those which contain from 15 to 20 per cent. of zinc possess the greatest ductility.

This Roman brass is therefore one of the most ductile of the whole series of brasses. It is, besides, identical in composition with Tournay's alloy (copper, 82·5 per cent.; zinc, 17·5 per cent.), which, on account of this property and its rich colour, is used for the manufacture of all French jewellery made from thin sheets in imitation of gold. Hence the brass of which the rosettes are made is notably of the composition which is best fitted for making such ornaments, and is that which would be employed at the present day.

I have also examined the scales forming part of a suit of Roman scale armour dug up in the excavations of a Roman camp near Melrose, and found them to be of practically the same composition as the above.

The chief use of brass by the Romans, apart from the various coinages, appears to have been for fibulæ and other personal ornaments and for decorative metal-work, and for these, as we have already seen, they had invented a metal perfectly suitable, both as to its workable qualities and its beauty.

That they were the first inventors of brass is, I think, without doubt, as the alloy is not found in Greece or the Greek colonies or elsewhere until the time of the Roman Empire.

In the eleventh century great care was bestowed on the purification of the copper intended to be used in the manufacture of calamine brass for objects of art, more especially for the removal of lead, as it had been found that brass contaminated with that metal could not be satisfactorily gilt.

As regards the brass which was made in this country by the ancient method, *i.e.* "calamine brass," and that made with spelter, the former, according to Dr. Percy, was preferred for the manufacture of buttons and articles to be gilt, as it was said to take the gold better in "water-gilding." It was also preferred for other purposes. It is difficult to see why there should be any difference between the two brasses unless the spelter of those days was more impure than at present, possibly containing more lead and iron. Prejudice against the metal made by a new process may, however, have been one of the causes of the opposition which was raised to its use.

With the disappearance of the calamine brass, one of the last links in the chain connecting the modern metallurgy of copper and its alloys with antiquity is broken. An important link, however, still remains in the *cire perdu* process of casting bronze, a process in which it can scarcely be said that we are any further advanced than the Greek founders of some centuries before our era.

Further, it must not be overlooked that the principles on which copper-refining is based were carried out in practice in the time of Pliny.

The influence of copper, and particularly of bronze, from the age of Bronze to that of Imperial Rome, is an element which has played a greater part in the civilisation of Europe than that of any other metal. This is often lost sight of in this age of iron and steel. It hence seemed to me that it might be of interest and possibly of profit to present to the members of our Institute an account of the achievements which our fellow-workers in bygone ages were able to accomplish without the elaborate appliances and scientific knowledge of our own times.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

LONDON.—Further gifts to the University are announced in connection with the scheme for removing the headquarters to a site behind the British Museum, to which we referred last week. The Duke of Bedford has offered 25,000*l.* and a reduction off the price of the site of 50,000*l.*, and an anonymous friend of the University has offered 70,000*l.*, making a total amount, with the gifts announced last week, of 305,000*l.* Although Lord Rosebery's name has been published as representing the University on the board of trustees which has been formed in connection with the scheme, the approval of the Senate has not been given to the proposals. Strong exception was taken to the Chancellor's action at the meeting of the Senate of March 20, when the Vice-Chancellor (Sir William Collins) tendered his resignation in view of what had taken place. At the unanimous wish of the Senate, he afterwards consented to remain in office. Lord Rosebery's explanatory letter was subsequently published, in which he states that by consenting to act as trustee he was committing no one, not even himself, to anything except to his being trustee for certain sums collected for the benefit of the University. From official correspondence which has been communicated to the Press, it appears that both the Prime Minister and the Chancellor of the Exchequer approved the proposed site.

Prof. F. G. Donnan, F.R.S., was appointed by the Senate to the University chair of general chemistry at University College, in succession to Sir William Ramsay, the appointment to take effect from the opening of next session, in October. The Senate elected Dr. L. N. G. Filon, F.R.S., to the Goldsmid chair of applied mathematics and mechanics, tenable at University College, such appointment to take effect from the beginning of next session, in October. Dr. Filon succeeds Prof. Karl Pearson, who resigned the chair in question on his appointment to the Galton chair of eugenics.

At the same meeting of the Senate, E. C. Snow, an internal student of University College, was granted the D.Sc. degree for a thesis entitled "The Intensity of Natural Selection in Man," and other papers.

Additional grants from the London County Council, amounting to 28,000*l.* during the sessions 1911–12 to 1913–14, were formally announced to the Senate.

IT is announced in *Science* that Prof. R. Ramsay Wright, vice-president of the University of Toronto and dean of the faculty of arts, will retire from active service on September 30. He has filled the chair of biology for the last thirty-eight years.

THE Board of Agriculture has again made an increased grant of 1300*l.* to Wye College, and has promised a grant of 262*l.* (for six months) for the cost of investigations on hops, on the life-history of the parasitic stomach worms (Strongyli) of sheep, and on the disease of "struck" of sheep, whilst the institution of a fresh grant of 1000*l.* towards the expense of an advisory staff in entomology and mycology—more particularly for fruit-growers—has also been officially intimated to the college authorities.

THE treasurer of Columbia University has reported to the trustees, says *Science*, that he has received about 310,000*l.* from the executors of the estate of the late Mr. George Crocker. Accordingly, the work of cancer research, for which Mr. Crocker gave this sum as an endowment, will begin at once. The research fund will be entrusted for administration to a board of managers, to consist of representatives of the trustees and of the medical faculty, together with a director of cancer research to be appointed.

THE Cambridge University Press has published a report by Mr. E. R. Burdon on a visit, undertaken in accordance with a resolution of the Forestry Committee of the University of Cambridge, for the purpose of studying the research work and educational methods of the forestry departments and forestry schools in those countries in connection with the study of timber and other forest products. An excellent description is provided of the departments of the Products Branch of the United States Forest Service, including particularly the Forest Products Laboratory at Madison, Wis., and the Office of Wood Utilisation, Chicago. The forestry schools of Yale, Harvard, Michigan, and Toronto Universities were visited by Mr. Burdon, and the particulars here brought together should prove of great service in this country.

IN an article in the Bulletin of the Society for the Promotion of Engineering Education for the present month, Profs. W. S. Franklin and Barry MacNutt deal with the teaching of elementary physics. They confine their attention in this case wholly to lectures and text-book work, though they recognise fully the paramount value of laboratory practice. Commenting upon the answers of 164 freshman engineering students—who had taken elementary mechanics for half a year—to a series of simple questions, the writers come to the conclusion that the great majority of young men cannot realise the meaning of simple English when it is impersonal and non-anthropomorphic, and a large proportion of the failures to answer the questions were due to the inability of the men to read the questions intelligibly. The object of elementary physics, the authors urge, should be to develop "rational insights." It is not the duty to a teacher of elementary physics to give his students a survey of the science.

THE report of the Board of Education for the year 1910–11 is now available (Cd. 6116). From it we find that though there were 768,358 students in attendance at evening and similar schools in 1909–10, as compared with 752,356 in 1908–9, nearly 18 per cent. of the students enrolled failed to complete the small minimum of attendances required in order to enable grants to be paid towards their instruction. In the administrative counties (excluding London) each student received, on an average, 45 hours of instruction. There was reason to expect the average would be lower in rural than in urban areas; only in eight cases, however, was the average below 30 hours, and in three cases it was 60 or more. The total amount of advanced instruction of the kind provided in technical institutions is still disappointingly small. There were 49 technical institutions at which courses were recognised as eligible for grant in 1909–10. In the case of 37 institutions for which alone the statistics are complete, there were 3032 students enrolled, of whom 2664 qualified for grant, and 1806 of these took full courses of instruction. There is still a tendency, the report states, to admit students to technical institutions before they have had an adequate course of general education.

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, March 21.—Sir Archibald Geikie, K.C.B., president, in the chair.—Lord **Rayleigh**: The self-induction of electric currents in a thin anchor-ring.—Hon. R. J. **Strutt**: The after-luminosity of electric discharge in hydrogen observed by Hertz. Hertz observed that if Leyden-jar discharges were passed through hydrogen at a pressure of, say, 100 mm., the gas remains luminous for a small fraction of a second afterwards. It is concluded that Hertz's effect is due to the presence of sulphuretted hydrogen in the hydrogen employed. It is conjectured that sulphuretted hydrogen is decomposed by the discharge, that sulphur vapour emerges in a specially active state, and that it then unites with hydrogen, the blue glow accompanying this process. Prof. J. H. **Poynting**: The changes in the dimensions of a steel wire when twisted, and on the pressure of distortional waves in steel. In a former paper (Proc. Roy. Soc., A, vol. lxxxii., 1909) the author described experiments showing that when a loaded wire is twisted it lengthens by an amount proportional to the square of the angle of twist. In this paper it is shown that if the wire is previously straightened by heating it under tension, the lengthening is, within errors of measurement, the same for all loads which could be applied, so that, as was supposed, the only function of the load in the earlier experiments is to straighten the wire. In all wires examined so far, the lowering is symmetrical about a point a fraction of a turn always in the counter-clockwise direction from the condition of no twist.—H. S. **Patterson**, R. S. **Cripps**, and R. **Whytlaw-Gray**: The orthobaric densities and critical constants of xenon. Using a carefully purified sample of xenon prepared from 150 c.c. of the gas lent by Sir William Ramsay, measurements were made of the orthobaric densities between the temperature limits of 16 and $-66.8°$ C. The variation of the mean density of liquid and saturated vapour with temperature was found to follow closely Cailletet and Mathias's law, and the results are expressed by the equation $D_t = 1.205 - 0.003055t$, where D_t = mean density at $t°$ C. The slope of the diameter is abnormally large, and is practically identical with the value for the argon diameter recently found by Onnes. The constants $T_c = 16.6°$ C. and $P_c = 58.2$ atms. were found, and the following were calculated from the results:—critical density, 1.115 grms. per c.c.; density of liquid close to boiling point, 3.063 grms. per c.c.; atomic volume close to boiling point, 42.7 grms. per c.c.—W. A. **Harwood** and Dr. J. E. **Petavel**: Experimental work on a new standard of light. The source of light consists of a strip of platinum heated by an electric current. The thermopiles measure the radiation passing through (*a*) a plate of black fluorspar, (*b*) a water-trough. The thermopiles are connected in opposition. As the current through the strip is increased, the intensity of the luminous radiation increases more rapidly than the intensity of the radiation of longer wave-length. Therefore, for a given thickness of the absorbing media and distance of the thermopiles, there will be one definite temperature at which the reading of a galvanometer in the thermopile circuit will be zero. A long series of experiments showed that the light could be kept constant within ±0·5 per cent. when a constant temperature was maintained by the above criterion.—J. A. **Crowther**: The distribution of the scattered Röntgen radiation. Experiments have been made to determine accurately the distribution of the scattered Röntgen radiation round a radiator. It has been found that the radiation can be divided into two parts: a true scattered radiation, distributed in accordance with the usually accepted theory of the scattering, and an additional or excess radiation. The curves representing the distribution of the latter have been found to resemble those previously obtained for a parallel pencil of β rays after passing through thin sheets of matter.—E. A. **Owen**: The passage of homogeneous Röntgen rays through gases. (1) The absorption coefficient of the different homogeneous radiation in a light gas such as CO_2 or SO_2 is proportional to the absorption of radiations in air. (2) The absorption of homogeneous radiation in a gas is proportional to the pressure of that gas. (3) For the homogeneous rays emitted by metals of atomic weight ranging from that of iron to that of molybdenum, the coefficient of absorption in the gases investigated is approximately inversely proportional to the fifth power of the atomic weight of the radiator which emits that characteristic radiation, *i.e.* $\lambda \alpha \omega^{-5}$. (4) The amount of ionisation produced in a thin layer of a gas is directly proportional to the pressure of the gas. (5) The ionisation relative to air is approximately constant in the same gas for the different homogeneous rays. (6) The total number of ions produced by homogeneous beams of equal intensity is approximately the same in each gas for any particular type of rays.—J. C. **Chapman**: Fluorescent Röntgen radiation from elements of high atomic weight.—J. A. **Gray**: The nature of γ rays excited by β rays. A determination has been made of the relative amount of emergent and incident γ radiation excited in "radiators" of different thicknesses and different materials. Results of the experiments are:—(1) The emergent γ radiation is generally greater in amount than the incident radiation, and is more penetrating. (2) The ratio of emergent to incident γ radiation is greater, for radiators of the same material, the thinner the radiator; for radiators of different materials thick enough to stop the β rays, the lower the atomic weight of the radiator. (3) The results obtained point to the conclusion that the excited γ ray is an entity, the direction of which is nearly that of the β ray exciting it. (4) The chance of a β ray making a γ ray is roughly proportional to the atomic weight of the radiator, provided the β ray spends its range in the radiator.

Geological Society, March 13.—Dr. Aubrey Strahan, F.R.S., president, in the chair.—Dr. R. L. **Sherlock** and A. H. **Noble**: The glacial origin of the Clay-with-Flints of Buckinghamshire, and on a former course of the Thames. The superficial deposits are divided into Clay-with-Flints with the associated Gravelly Drift, and the Fluvioglacial Gravels. Certain high-level gravels, older than any of these, and also the river-gravels and alluvium of the present streams, are not dealt with in the paper. The evidence shows that the Clay-with-Flints and Gravelly Drift were formed by an ice-sheet which came from the north or north-west over the Chiltern Hills. Only the clean upper layers of ice surmounted the escarpment, and this produced the Clay-with-Flints and Gravelly Drift. At that time the Thames flowed from Bourne End through Beaconsfield and Rickmansworth to Watford. The ice-sheet blocked the river-channel between Bourne End and Rickmansworth, and diverted the Thames southwards at Bourne End. The river beyond Watford was further blocked by the Eastern Drift. On the melting of the ice, Fluvioglacial Gravels were left over a great area. These gravels are composed chiefly of Eocene and Cretaceous materials derived from the Gravelly Drift. The floods from the melting ice, added to the waters of the Thames and Colne, produced the great flat through which the Thames now flows. After the retreat of the ice, the Wye and Misbourne extended their channels over the Fluvioglacial Gravel flat, and some other small streams were formed.—Jane **Longstaff**: Some new Lower Carboniferous gasteropoda. Eight species of gasteropoda are described, six being regarded as belonging to five new genera or subgenera, the others representing Pithodea, De Koninck, which has not previously been recorded from the British or Irish Carboniferous Limestone.

Linnean Society, March 21.—Dr. D. H. Scott, F.R.S., president, in the chair.—Dr. I. **Bolivar** and C. **Ferrière**: Orthoptera-Phasmidæ of the Seychelles. —J. A. **Liddell**: *Nitocrameira bdellurae*, a new genus of parasitic Canthocamptidæ.—W. **West** and Prof. G. S. **West**: The periodicity of the phytoplankton of some British lakes.

Paris.

Academy of Sciences, March 11.—M. Lippmann in the chair.—C. **Guichard**: Osculating circles and osculating spheres to the lines of curvature of a surface. —M. Lucas-Championnière was elected a member of the section of medicine and surgery in the place of the late O. M. Lannelongue.—MM. **Fayet** and **Schaumasse**: The elliptical character of the Schaumasse comet (1911*h*).—E. **Vessiot**: Permutable functions and continuous groups of linear functional transformations.—V. **Jamet**: Certain complexes of lines.—Rodolphe **Soreau**: Generalisation of Massau's construction and abacus for solving equations of the form $z^{\alpha+\beta} + nz^{2\beta} + pz^{\beta} + q = 0$.—MM. **Papin** and **Rouilly**: The gyropter. Two diagrams completing the note published on March 4.—Samuel **Lifchitz**: The displacement of the particles in the Brownian movement. The explosive shock of the spark as the cause of the phenomenon.—Ch. **Féry**: A new thermoelectric combustion calorimeter. A calorimetric bomb is fixed by two discs of constantan in an external metallic envelope, the latter and the constantan discs forming a thermocouple. The rise of temperature observed, which is high owing to the absence of water, is read directly on a millivoltmeter.—Jean **Escard**: Some practical arrangements for the determination of the densities of solid bodies of small volume. A description of a volumometer modified to measure accurately the density of solids having volumes from 1 c.c. to 3 c.c.—P. Th. **Muller** and E. **Carrière**: The refraction and dispersion of the mercury nitrates.—J. **Meunier**: Some mechanical phenomena of gaseous combustion. The spiral flame.—H. **Baubigny**: Researches on the formation of dithionic acid in the reaction between alkaline sulphites and copper salts.—V. **Hasenfratz**: Apoharmine-carboxylic acid, apoharmine, and some derivatives of this base. —Marcel **Sommelet**: γ-Ethoxyacetoacetic ester. This ester is obtained by the interaction of ethoxyacetic acid, bromacetic acid, and zinc.—Mme. **Ramart-Lucas**: The action of phenylmagnesium bromide upon pinacoline and on methylpinacoline.—H. **Pariselle**: Study of the unsaturated alcohol

$$CH_2{=}CH{-}CH_2{-}CH(OH){-}CH_3.$$

This alcohol was prepared by the interaction of allyl bromide, acetaldehyde, and magnesium. Its properties are described, and also those of its acetate and chloride.—Marcel **Guerbet**: The action of caustic potash on the tertiary alcohols: a new method for the diagnosis of these alcohols.—A. **Mailhe** and M. **Murat**: The nitro derivatives of phenyl oxide.—J. **Virieux**: *Achromatium oxaliferum*.—Victor **Dupont** and Jean **Gautrelet**: General anæsthesia by the rectum, using titrated mixtures of air and chloroform or the vapours of ethyl chloride. Details of experiments on the rabbit.—Jacques **Pellegrin**: The dentition of *Mobula olfersi*.—D. **Keilin**: The anatomy and development of *Belgica antarctica*. Work done on material collected by M. Gain in the course of the expedition of the *Pourquoi-Pas?*—E. Daday **de Dées**: The polymorphism of the males in certain phyllopods.—A. **Cligny**: The marine migration of the common eel. In November, 1911, and January, 1912, about a dozen eels were caught in the English Channel about 20 miles from the coast of Cornwall. A detailed account of the condition of one of these, a female, is given.—M. **Flajolet**: Contribution to the application of wireless telegraphy to the prediction of storms. A description of some arrangements for increasing the sensibility of the recording apparatus. With these modifications, the apparatus gives indications of electrical disturbances when the storm is from ten to twenty-four hours distant.—A. **Baldit**: The electrical charges of rain at the Puy-en-Velay in 1911.

March 18.—M. Lippmann in the chair.—J. **Boussinesq**: The explanation of the instantaneous action of gravity and molecular forces, without successive propagation, at all distances at which the forces are produced round the material points from which they emanate.—A. **Haller**: Phenyl-, *p*-tolyl-, and diphenyloxyhomocampholic acids and their transformation into benzylidene-*p*-tolylidene- and diphenylmethylene camphors.—Ch. Ed. **Guillaume**: The expansion of commercial nickel. Although the coefficient of expansion of nickel is greater than that of invar (nickel-steel), it has the advantage of withstanding corrosion after prolonged immersion in water. The coefficient of expansion of bars of commercial nickel has been studied over a period of twenty years, and a gradual diminution in the coefficient has been noted.—M. Constantin was elected a member of the section of botany in the place of the late M. Bornet.—Emile **Belot**: The formation of rings in the Laplace nebula.—H. W. E. **Jung**: The invariant of Zeuthen and Segre.—Jean **Chazy**: A differential equation of which a coefficient is a divergent series.—Louis **Roy**: Waves of shock in the motion of flexible membranes.—Charles **Reignier**: The starting period in aëroplane motors. Unless the motor takes a certain minimum time to attain full power, there is a risk of breaking the propeller or transmission gear. The relation between this time and the strength of the moving parts is investigated in this paper.—Georges **Meslin**: The interference fringes obtained with the Fresnel triprism.—G. A. **Hemsalech**: The influence of capacity, of self-induction, and of the explosive distance on the velocity of luminous vapours in the electric spark. The velocity of the metallic vapour is not sensibly changed by varying the capacity; it varies inversely as the self-induction of the discharge circuit, and directly as the explosive distance.—P. **Mesernitsky**: Contribution to the study of the decomposition of uric acid by the action of the radium emanation.—Camille **Matignon**: The equilibrium of the system cadmium sulphate, hydrogen chloride.—P. **Mélikoff** and M. **Becaia**: The estimation of phosphoric acid in presence of colloidal silicic acid.—G. **Chavanne**: The ethylene isomerism of acetylene bichloride.—J. B. **Senderens**: The catalytic dehydration of the fatty alcohols in the wet way by means of sulphuric acid. Experimental evidence in favour of the view that the formation of ethylenes from alcohols by the action of sulphuric acid is a catalytic effect, and is not due, as is commonly supposed, to a direct withdrawal of water from the alcohols by the acid.—H. **Duval**: Researches on the endoazoic compounds.—Mme. Paul **Lemoine**: The general characters of the Arctic and Antarctic genera of the calciferous algæ.—L. **Cuénot** and L. **Mercier**: Study of cancer in mice.—A. **Trillat** and M. **Fouassier**: The influence of the nature of the gases dissolved in water on the vitality of micro-organisms. The nature of the dissolved gases in water is an important factor in the multiplication and preservation of pathogenic organisms. The results with the Eberth bacillus are especially emphasised.—F. de Montessus **de Ballore**: Luminous phenomena accompanying great earthquakes.

BOOKS RECEIVED.

Alle Fonti della Vita. Prolegomeni di Scienza e d'arte per una Filosofia della Natura. By Dr. W. Mackenzie. Pp. 387. (Genoa: A. F. Formiggini.)

Cambridge County Geographies:—West London. By G. F. Bosworth. Pp. xii+267. Breconshire. By C. J. Evans. Pp. xi+172. Oxfordshire. By P. H. Ditchfield. Pp xi+218. (Cambridge: University Press.) Each 1*s*. 6*d*.

Einführung in die Biologie. By Prof. O. Maas and Dr. O. Renner. Pp. ix+394. (München & Berlin: R. Oldenbourg.) 8 marks.

The Student's Handbook of Stratigraphical Geology. By A. J. Jukes-Browne. Second edition. Pp. xiv+668. (London: E. Stanford.) 12*s*. net.

Ctenophores of the Atlantic Coast of North America. By A. G. Mayer. Pp. 58. (Washington: Carnegie Institution.)

The British Tunicata. By the late J. Alder and the late A. Hancock. Edited by J. Hopkinson. Vol. iii. Pp. xii+113. (London: The Ray Society.) 12*s*. 6*d*. net.

A Monograph of the British Desmidiaceæ. By W. West and Prof. G. S. West. Vol. iv. Pp. xiv+191+ plates. (London: The Ray Society.) 25*s*. net.

Achondroplasia: its Nature and its Cause. By Dr. M. Jansen. Pp. 98. (Leyden: E. J. Brill, Ltd.)

An Elementary Treatise on Statics. By Prof. S. L. Loney. Pp. viii + 393. (Cambridge: University Press.) 12*s*.

Year-Book of the Royal Society of London, 1912. Pp. 256. (London: Harrison and Sons.) 5*s*.

Is the Mind a Coherer? By L. G. Sarjant. Pp. 304. (London: George Allen and Co., Ltd.) 6*s*. net.

Principles and Practice of Poultry Culture. By J. H. Robinson. Pp. xvi+611. (London, Boston, &c.: Ginn and Co.) 10*s*. 6*d*.

Stanford's Geological Map of Central Europe. (London: E. Stanford.) 5*s*.

Prüfung der chemischen Reagenzien auf Reinheit. By E. Merck. Zweite Auflage. Pp. v+332. (Darmstadt: E. Merck.)

Die Süsswasserfauna Deutschlands. Eine Exkursionsfauna. Edited by Prof. Brauer. Heft 14. Pp. iv+273. (Jena: G. Fischer.) 7 marks.

Text-book of Embryology. By Dr. F. R. Bailey and A. M. Miller. Second edition. Pp. xvii+672. (London: J. and A. Churchill.) 21*s*. net.

Outlines of Applied Optics. By P. G. Nutting. Pp. ix+234. (Philadelphia: P. Blakiston's Son and Co.) 2 dollars net.

Prehistoric Thessaly: being some Account of Recent Excavations and Explorations in North-eastern Greece from Lake Kopais to the Borders of Macedonia. By A. J. B. Wace and M. S. Thompson. Pp. xvi+272+6 plates. (Cambridge: University Press.) 18*s*. net.

Weather Signs and how to read them, for Use at Sea. By W. Allingham. Pp. 117. (Glasgow: J. Brown and Son.) 2s. net.

Smoke: a Study of Town Air. By Prof. J. B. Cohen and A. G. Ruston. Pp. 88. (London: E. Arnold.) 5s. net.

Water Analysis for Sanitary and Technical Purposes. By H. B. Stocks. Pp. viii+136. (London: C. Griffin and Co., Ltd.) 4s. 6d. net.

Cast Iron in the Light of Recent Research. By W. H. Hatfield. Pp. xiii+249. (London: C. Griffin and Co., Ltd.) 10s. 6d. net.

Dynamic Meteorology and Hydrography. By Prof. V. Bjerknes and others. Part ii.: Kinematics. Pp. vii+175 and vol. of plates. (Washington: Carnegie Institution.)

Revision of the Amphibia and Pisces of the Permian of North America. By Prof. E. C. Case and others. Pp. 178+plates. (Washington: Carnegie Institution.)

The Annual of the British School at Athens. Index to Nos. i. to xvi. Compiled by A. M. Woodward. Pp. vi+144. (London: Macmillan and Co., Ltd.) 10s. net.

Wörterbuch der Mikroskopie. By H. Günther and Dr. G. Stehli. Pp. 96. (Stuttgart: Franckh'sche Verlagshandlung.) 2 marks.

Elementare Mechanik ein Lehrbuch. By Prof. G. Hamel. Pp. xviii+634. (Leipzig & Berlin: B. G. Teubner.) 16 marks.

Lebensweise und Organisation. By Prof. P. Deegener. Pp. x+288. (Leipzig & Berlin: B. G. Teubner.) 5 marks.

Theorie der Elektrizität. By Dr. M. Abraham. Erster Band. Vierte Auflage. Pp. xviii+410. (Leipzig & Berlin: B. G. Teubner.) 11 marks.

Maschinen und Apparate der Starkstromtechnik: ihre Wirkungsweise und Konstruktion. By G. W. Meyer. Pp. xiv+590. (Leipzig & Berlin: B. G. Teubner.) 15 marks.

Mathematical Papers for Admission into the Royal Military Academy and the Royal Military College for the Years 1905–1911. Edited by R. M. Milne. (London: Macmillan and Co., Ltd.) 6s.

Catalogue of 9842 Stars, or all Stars very Conspicuous to the Naked Eye, for the Epoch of 1900. By T. W. Backhouse. Pp. xx+186. (Sunderland: Hills and Co.)

Hints to Autopianists and Users of Player Pianos and Piano Players in General. Pp. 46. (London: Kastner and Co., Ltd.) 3s. net.

DIARY OF SOCIETIES.

THURSDAY, MARCH 28.

ROYAL SOCIETY, at 4.30.—A Confusion Test for Colour Blindness: Dr. G. J. Burch, F.R.S.—On the Systematic Position of the Spirochætes: C. Dobell.—The Influence of Selection and Assortative Mating on the Ancestral and Fraternal Correlations of a Mendelian Population: E. C. Snow.—The Human Electrocardiogram; a Preliminary Investigation of Young Male Adults, to form a Basis for Pathological Study: T. Lewis and M. D. D. Gilder.—The Production of Variation in the Physiological Activity of *B. coli* by the Use of Malachite-Green: C. Revis.—(1) Notes on some Flagellate Infections found in certain Hemiptera in Uganda; (2) Notes on certain Aspects of the Development of *T. gambiense in Glossina palpalis*: Muriel Robertson.—Antelope and their Relation to Trypanosomiasis: Dr. H. L. Duke.

ROYAL INSTITUTION, at 3.—Sexual Dimorphism in Butterflies: F. A. Dixey, F.R.S.

CHEMICAL SOCIETY, at 4.30.—Presidential Address: Some Stereochemical Problems: Prof. Percy F. Frankland, F.R.S.

INSTITUTION OF ELECTRICAL ENGINEERS, at 8.—The Power Factor and Conductivity of Di-electrics when tested with Alternating Electric Currents of Telephonic Frequency at Various Temperatures: Dr. J. A. Fleming, F.R.S., and G. B. Dyke.

FRIDAY, MARCH 29.

ROYAL INSTITUTION, at 9.—Results of the Application of Positive Rays to the Study of Chemical Problems: Sir J. J. Thomson, O.M., F.R.S.

GEOLOGISTS' ASSOCIATION, at 8.—The Geology of South-east Carnarvonshire: W. G. Fearnsides.

INSTITUTION OF CIVIL ENGINEERS, at 8.—The Eastern Wharf Reconstruction, Dundee: C. R. Shaddick.

SATURDAY, MARCH 30.

ROYAL INSTITUTION, at 3.—Molecular Physics: Sir J. J. Thomson, O.M., F.R.S.

ESSEX FIELD CLUB, at 6 (at the Essex Museum, Stratford, E sex).—The Alkaline Waters of the London Basin: Dr. J. C. Thresh.

MONDAY, APRIL 1.

SOCIETY OF ENGINEERS, at 7.30.—Ligno-Concrete: G. O. Case.

ROYAL GEOGRAPHICAL SOCIETY, at 8.30.—The Mountains of Northern Sikhim and Garhwal: A. M. Kellas.

ARISTOTELIAN SOCIETY, at 8.—The Time Difficulty in Realist Theories of Perception: Dr. Wm. Brown, H. Wildon Carr, Prof. G. Dawes Hicks, and Prof. F. B. Jevons.

ROYAL SOCIETY OF ARTS, at 8.—Materials and Methods of Decorative Painting: Noel Heaton.

VICTORIA INSTITUTE, at 4.30.—Archæology and Modern Biblical Scholarship: Rev. John Tuckwell.

SOCIETY OF CHEMICAL INDUSTRY, at 8.—The Theory of Sulphuric Acid Manufacture: W. C. Reynolds and W. H. Taylor.—The Estimation of Sulphides in Lime Liquors: J. R. Blockey and P. B. Mehd.

TUESDAY, APRIL 2.

RÖNTGEN SOCIETY, at 8.15.—The Physiological Principles of Internal Radium Therapy: Dr. Saubermann.

ZOOLOGICAL SOCIETY, at 8.30.—Lantern Exhibition of Nestling Cariama, and the Display of the Peacock Pheasant: D. Seth-Smith.—On a Rare Stag (*Cervus wallichii*) from Nepal, presented to the Society by H.M. the King: R. I. Pocock, F.R.S.—Contributions to the Anatomy and Systematic Arrangement of the Cestoidea.—IV. On Species of *Inermicapsifer* from the Hyrax and on the Genera *Zschokkeella*, *Thysanotaenia*, and *Hyracotaenia*: F. E. Beddard, F.R.S.—Additional Notes on the Living Specimens of the Australian Lung-Fish (*Ceratodus forsteri*) in the Collection of the Zoological Society of London: Dr. Bashford Dean.—*Probable Papers*: A First Account of the Courtship of the Redshank (*Totanus calidris*: J. S. Huxley.—Amphipoda from Bremerhaven: Mrs. E. W. Sexton.—Descriptions of New Fishes of the Family Loricariidæ in the British Museum Collection: C. Tate Regan.

INSTITUTION OF CIVIL ENGINEERS, at 8.—The Works for the Supply of Water to the City of Birmingham from Mid-Wales: E. L. Mansergh and W. L. Mansergh.

WEDNESDAY, APRIL 3.

SOCIETY OF PUBLIC ANALYSTS, at 8.—Note on the Milk of a Small Herd: E. Russell.—The Separation of Arsenic from Antimony: S. W. Collins.—The Estimation of Ferric Iron in Presence of Organic Matter: Dr. J. T. Hewitt, F.R.S., and Gladys R. Mann.—The Relation of the Kirschner and Polenske Values in Margarine containing Cocoanut and Palm Kernel Oils: E. R. Bolton, H. D. Richmond, and C. Revis.—A Convenient Apparatus for Obtaining an Average Sample of Gas, and for Regulating the Flow of a Gas into an Evacuated Vessel: F. S. Sinnatt.

ENTOMOLOGICAL SOCIETY, at 8.

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