THURSDAY, NOVEMBER 8, 1906.

SCIENCE AND FOLLY.

The Seven Follies of Science: a Popular Account of the most famous Scientific Impossibilities and the Attempts which have been Made to Solve Them. By John Phin. Pp. viii + 178. (London: Archibald Constable and Co., Ltd., 1906.) Price 5*s.* net.

THESE "Follies" are the squaring of the circle, the duplication of the cube, the trisection of an angle, perpetual motion, the transmutation of metals, the fixation of mercury, and the elixir of life; we miss from this list the flattening of the earth. The author is an American; he writes for ordinary readers, and makes his subject interesting; he seems to make no mistakes. He dwells at much greater length upon the first and fourth of the follies than the rest. In addition to these seven classical ones he gives an account of four others: perpetual lamps, the alkahest or universal solvent, palingenesy (the revival of a plant or animal from its ashes), and the powder of sympathy. He adds a division on the fourth dimension of space and some paradoxes, micrography, illusions of the senses, and two tricks. The book finishes with an account of some arithmetical problems and the fulcrum of Archimedes which are probably "curious" to the ordinary reader.

Readers of NATURE, and not merely ordinary readers, may spend a pleasant hour or two in looking through this book, reflecting on the follies, not of scientific persons, but of those persons supposed to be cultured who are ignorant of physical science in an age when applications of the principles of physical science are transforming the world. Our greatest legislators and writers and divines are no better guarded mentally from tricksters than their ancestors. We know that a new Mahomet might have just as much success with cultured and uncultured persons in the twentieth as in the seventh century, but it is startling to find that a new Cagliostro might probably be even more successful in the twentieth than in the eighteenth century. A scientific man does not deny the possibility of almost any miracle, he only says that it is extremely improbable. He admits that man is probably limited in his senses and faculties, and that all his physical laws are mere analogies; that real comprehension of the universe is altogether out of the question. These admissions have become known now to unscientific persons, and no Swedenborgian was more ready to take the cock-and-bull statements of his master on trust than 99 per cent. of newspaper readers and writers at the present time are willing to accept absurd stories as true. A cultured person says that of course a perpetual motion is impossible, but he invests his money in a company which promotes something which is really meant to create energy. He scorns the Middle Age idea that a sympathetic powder applied to a dagger will cure a distant wounded person, but although he has been to a public school he is a profound believer in Christian science.

Few men probably receive more communications from earth flatteners and circle squarers and arc trisectors than the present writer. When he receives one he does not feel pleased, and yet it ought to be pleasant to think that there are so many men in the world who refuse to accept dogma. A *crank* is defined as a man who cannot be turned. These men are all cranks; at all events, we have never succeeded in convincing one of them that he was wrong. The usually accepted axioms, definitions, and technical terms are not for them. When they use a term, sometimes evidently in two different senses in the same syllogism, it is impossible to find exactly what they mean by it. If Mr. Phin had had his reviewer's experience, he would have greatly added to the size of his book by referring to many parts of physics where men are just as unwilling now to accept authority as the men of whom he writes; and he would have pointed out that our real difficulty is with the men who are partly right, men who think they have a new idea and try to explain it in unscientific language, and, as they do so, denounce the orthodox beliefs which they have been unable to understand.

From many follies the common people have been saved for ever by the engineers, the men who apply science. In this twentieth century it is difficult to believe in sympathetic wax images and powders and the other things cherished by our ancestors who executed witches, because miraculous railway trains and telegraphs and telephones and thousands of things to be seen in every shop, on every street, on every road are known to be explainable in reasonable ways. To believe now in the evil eye or devil possession, ghosts, haunted houses, or the powers of the esoteric Buddhist it is necessary to have a very special kind of mental power and of education and environment. It may be that only one in every 100,000 of the inhabitants of these islands is capable of snatching the fearful joy which accompanies such beliefs.

As already said, we think that the author of this book makes no mistakes, but if he had known more he might have made the book a much larger one with advantage, and we cannot help thinking that he is not well read in the delightful memoirs of the sixteenth century, when witchcraft had a really good time. Then, as to a fourth or twentieth dimension in space, he gives practically no information to the expectant reader in this division of his work, yet there is probably no subject on which the cultured reader of the present day desires instruction more (perhaps excepting *radium*). A man may get some knowledge of Greek or Japanese literature without knowing the Greek or Japanese languages, and so the cultivated person hopes to get scientific ideas without knowing the language of science. The author hardly tries to hide his own ignorance of this part of his subject, and here, as everywhere else, he gives only what he himself feels sure that he understands. He writes for the man in the street, and we can give no higher praise than to say that the man in the street will understand him.

J. P.

PRACTICAL CHEMISTRY.

A Practical Chemistry Note-book for Matriculation and Army Candidates. By S. E. Brown. Pp. v+56. (London: Methuen and Co., n.d.) Price 1*s.* 6*d.* net.

Chemistry Note-books. Sections i.–iv. By E. J. Sumner. (Burnley: Cooper Printing Co., Ltd., n.d. Privately printed.) Section i., 6*d.*; section ii., 9*d.*; sections iii. and iv., 1*s.* each, net.

The Science of Common Life. By J. B. Coppock. Pp. vi+273. (London: Swan Sonnenschein and Co., Ltd., 1906.) Price 3*s.* 6*d.*

Practical Methods of Inorganic Chemistry. By Dr. F. M. Perkin. Pp. vii+155. (London: Archibald Constable and Co., Ltd., 1906.) Price 2*s.* 6*d.* net.

Chemical Analysis, Qualitative and Quantitative. By Drs. W. Briggs and R. W. Stewart. Fourth edition, revised by H. W. Bausor. Pp. xii+200. (London: University Tutorial Press, Ltd., W. B. Clive, 1906.)

Methods of Organic Analysis. By Dr. H. C. Sherman. Pp. xii+245. (New York: The Macmillan Co.; London: Macmillan and Co., Ltd., 1905.) Price 7*s.* 6*d.* net.

"OF writing many books there is no end" can be truly said of chemistry, but need not be said with a sigh. Whether the author aspires to say something new and useful, or tries to smooth the rough road for the anxious candidate, or merely writes to supply a want felt more by himself than the reader, the appearance of so much new literature, whatever its character, implies a widespread activity in practical teaching.

There is a hopeful look about most of these volumes on practical chemistry for junior students. With the exception of Briggs and Stewart's "Chemical Analysis," which has a certain flavour of chemistry as it was taught, the new volumes show that the subject offers something more instructive and exhilarating than the mere testing of simple or even complex salts—a few years ago the staple chemical diet of all beginners.

Although Mr. Brown's "Note-book" is written to prepare candidates for examination, this is no disparagement. Mr. Brown wisely does not attempt to explain in words what is more easily and quickly demonstrated, so that the volume is partly a book of instructions to the student, partly a guide-book to the teacher, and very largely a note-book of blank pages. The experiments, of which a number are minutely described, are well chosen and arranged, and provide an effective and varied programme, which should give a boy an excellent foundation to build upon. There is a doubt in the writer's mind whether this combination of text-book and note-book is entirely satisfactory, for the book will be used on the bench, and who does not recall the spotty and unwholesome appearance of the laboratory rough book towards the end of term, when acid and alkali, oxidising and reducing agent, have had time to work their natural and varied effect?

The object of Mr. Sumner's little note-books is rather a novel one. There are four sections corresponding to a four years' course. The printed matter is mainly a revision of what the student is supposed to have accomplished during the year and entered in his own manuscript note-book; but it is not complete, and certain blank spaces are left to be filled in at the end of the year's course from the aforesaid note-book. Thus the student is provided with a fair and accurate account of his year's work for reference. One does not wish to dogmatise about a matter of this kind of which one has had no experience, but, unless the student's notes are very badly kept, it seems doubtful whether the mere act of transcribing will be anything more than "a dull, mechanic exercise." The original manuscript will probably be the better reference in the end, for the student will be more familiar with its contents. On the other hand, a good word must be said for the excellence of the manner and matter of the different sections, from which a teacher, as well as a student, may derive valuable suggestions.

The little volume by Mr. Coppock, with the attractive title of "The Science of Common Life," contains a series of carefully selected and well-arranged experiments, but the evident care of the author is completely marred by a confused, verbose, and illiterate style of writing which would scarcely do credit to an ordinary schoolboy. The book abounds in such sentences as the following:—"Take a thermometer and warm it for about 20° higher up than its reading." "We thus get squared paper if their distance apart is made equal to that of the printed lines." "These gases consist of those found on page 206 together with large quantities of ammonia, which is removed on purification." Here is a sentence destitute of a verb and also, it may be added, of a meaning:—"The radiation depending upon the nature of the body and a closed screen to the sky, which holds the heat." "Eider-down quilts, furs and flannels are warm compared with corresponding linen articles." Imitation furs are not unknown, but an eider-down quilt, or a fur, or flannel made of linen would be an inexpensive and no doubt attractive article of commerce.

The descriptions and explanations are as slovenly as the style is bad:—"There is another oxide of carbon called carbon monoxide . . .; this is the gas often seen on a fire." Chapter ii. opens with the statement:—"It is a common expression to say that one thing is heavier than another," which might almost have passed as a truism; but the author is of another opinion, and proceeds to show that it might conceivably be the other way round—this by way of introducing the notion of density.

There is a mass of inaccurate detail with which it is needless to deal. Sufficient has been said to show that the book cannot be honestly recommended as a satisfactory or trustworthy guide.

It is now generally recognised that the attractiveness of a first year's college course may be greatly enhanced and its interest stimulated by varying the routine of analysis with the preparation of inorganic

and organic substances. The little book on "Practical Methods of Inorganic Chemistry," by Dr. F. M. Perkin, embodies many familiar inorganic preparations and a few useful quantitative estimations which will be of real service in the laboratory.

An added interest would have been given by a reference to the original author of each preparation. Whilst the book may be confidently recommended, attention should be directed to the numerous errors which have escaped correction. In turning over the pages mistakes have been found on p. 13, in which a *tarred* filter-paper is recommended, and on the following pp. 24, 47, 48, 49, 50, 55, 63, 76, 80, 104, 131, 139. Brinn (p. 63) should be Brin, Woolf (p. 92) should be Woulfe, and Golschmidt (p. 121) Goldschmidt. Urea is surely not diamido carbonic acid (p. 68). It is not an acid, but an amide.

The volume on "Chemical Analysis," by Drs. Briggs and Stewart, is one of the University Tutorial Series, and, like its companions, is intended for the use of candidates for university examinations. The authors do not lose sight of this important fact, and the student is encouraged by an occasional reminder that his interests, as well as those of the science, are properly served. "In case a student is told that only one metal is to be looked for, the process of analysis is of course much simplified," and further, "it is foolish to follow up an unsatisfactory result in an examination." That the book fulfils its purpose is clear from the numerous editions which it has seen, and, when all has been said, it is a thoroughly sound work on the subject with which it professes to deal. If it should fail in its aim to teach the principles of chemistry the fault does not lie with the authors, but with those examiners who insist upon a pabulum of this kind for their candidates.

Dr. Sherman's book on "Methods of Organic Analysis" belongs to an entirely different category from the foregoing. The subject of analysis is specialised, and appears in its proper *rôle* as the handicraft of the well-trained chemist. The book is chiefly devoted to the analysis of foodstuffs and the more common organic materials. The methods are minutely described, sources of error are pointed out, and references to original literature are given. The book is evidently compiled with care and from personal experience, and should be a valuable adjunct to the organic laboratory. J. B. C.

COTTON IN AMERICA.

Cotton: its Cultivation, Marketing, Manufacture, and the Problems of the Cotton World. By Prof. C. W. Burkett and C. H. Poe. Pp. ix+331. (London: A. Constable and Co., Ltd., 1906.) Price 8*s.* 6*d.* net.

THE story of cotton as told by Prof. C. W. Burkett, professor of agriculture in the North Carolina College of Agriculture and Mechanic Arts, and by Mr. C. H. Poe, the managing editor of a newspaper which caters for the American cotton farmer, is a story of great interest, though very incomplete. The book would be more correctly described by the title of "American Cotton," for India, Egypt, and other cotton fields, and the efforts of England to widen the sources of supply by producing cotton within the British Empire, are little more than subjects for the authors' derision.

The reader is to understand that there is no cotton in the world like American cotton; that there is no soil on earth so suitable for growing cotton as American soil; that nowhere on the globe are cotton farmers equal to those of America; and that the only requisite to constitute an ideal state of things is for all the cotton farmers to join Mr. Harvie Jordan's association, and to regulate the acreage and the price according to the principles of that association. What those principles are the authors do not define, but in the official journal of the association for September 27, 1906, they are stated thus:—

"Dismiss all consideration of spinner, or consumer; let the spinner look out for himself and the producer for himself. This is business."

Further "business," much of the same nature, is indicated by the authors in a chapter on stopping leaks in cotton profits, wherein they say "the greatest leak of all is the shipping of 60 per cent. of our cotton to Europe instead of turning it into the finished product here."

If it is the ambition and the determination of the United States of America not to let any cotton "leak" out of the country, and, according to the authors, the fibre cannot be successfully grown elsewhere, it would be interesting to learn what they propose to do with the cotton-manufacturing industry of Europe! On the Continent "American greed" has become a by-word, but so far English people have had no cause so to express their opinion of Americans, and we refuse to believe that the authors of "Cotton" express anything more than a narrow, selfish class interest in their advocacy of American cotton for Americans, and at such a price as the growers' associations determine.

The value of the book lies in section ii., which contains a description of how the cotton-plant grows and is grown. To cotton farmers this section alone is worth the 8*s.* 6*d.* asked for the book. It treats of the botanical structure of the plant, seed selection, environment, climatic conditions, fertilisers, farm tools required, injurious insects, planting, cultivating, picking, and the cost of making cotton.

In speaking of ginning, we are told the tendency is to run the gins at high speed, but that this, though increasing the output, decreases the value of the lint. Whilst the great speed of the power gins is held up for admiration and wonder, it has to be confessed that "the old gin, when run by horse-power, was not open to this objection (maltreating fibre) urged against high steam power. Then you never heard of cut or broken fibres, or of crimped or knotted lint, such as is now caused by the impact of the saws when the cylinders rotate at high speed." There is a further confession that "no noteworthy improvement

in the cotton gin has been made since it was introduced "—more than 100 years ago—and an authority is quoted as saying that "the saw gin actually wastes or destroys over 6 per cent. of all the cotton raised in the Southern States, meaning the destruction each year of nearly 40,000,000 dollars worth of property belonging to the farmers of the South." By other quoted authorities it is stated that "the saw gin destroys over 40 per cent. of the initial strength of the cotton fibre." It is also pointed out that, besides this waste, cotton can only be pressed to 14 lb. per cubic foot at the ginneries.

"A fortune," say the authors, "awaits the man who will invent a compress requiring small horse-power, so that the bales, with one handling at the gin, may be compressed tightly enough for export purposes; just as a fortune awaits the man who will invent a roller gin for upland cotton by which the present waste and the barbarous laceration of the fibre may be obviated."

Such a statement is strong testimony of the authors' lack of knowledge of cotton affairs. Do they not know that there is a press in their own country which can be affixed to a gin and turn out a bale compressed to 35 lb. per cubic foot, and that it only takes 5 h.p. to drive it? Do they not know that in England gins are built which neither cut the cotton nor weaken the fibre, whether used on the long staple of Egypt or the short staple of India? Do they not know that American trusts are trying to defeat one of these longed-for improvements, and American tariffs prohibit the other?

The remarks about baling are specially interesting as coming from friends of the farmer. After observing that "like the gin, the baling press has been materially improved in rapidity and in efficiency" (they told us on a previous page that no noteworthy improvement to the gin had been made since it was introduced, and that the old horse-driven gin did better work than the modern steam-power gin), they remark that "as a rule, the American bale is not prepared with such care as its importance demands," that the covering is torn, allowing the lint to drop out, that on bringing it back from the gin the farmer puts it under the apple tree or in the barn lot, or in some open, exposed place, "where rain and dust attack and damage it, and even pigs are allowed access to it on which to clean their muddy backs."

After making such a charge against the business capacities of the cotton farmer, is it not stretching a point to ask us to believe that these people who so mismanage their own business can by combination regulate the buying and selling of cotton on better or more economical lines than on the old law of supply and demand?

"Cotton" is very well printed, its illustrations are excellent, but from its numerous examples of bad English, the rhetorical extravagances indulged in by the authors, and the narrow views they take of political economy as affecting nation and nation, we are afraid their chances of being accepted as authoritative contributors to human knowledge are greatly jeopardised.

BOTANICAL DICTIONARIES.

(1) *Illustriertes Handwörterbuch der Botanik.* By Several Authors, and with the collaboration of Dr. O. Porsch and C. K. Schneider. Pp. vii+690; with 341 figures. (Leipzig: Engelmann, 1905.) Price 16*s.* net.

(2) *Dizionario di Botanica Generali.* By Dr. Guglielmo Bilancioni. Manuali Hoepli. Pp. xx+926. (Milan: U. Hoepli, 1906.) Price L10.

(1) IT would be an interesting question to discuss in its technical connections what are the differences between a glossary, a dictionary, and an encyclopædia of botany, but space will not allow of that, and we may pass on to say that this heavy book, typically German and written by Germans for Germans, stands in sharp contrast, with its unequal paragraphs—for instance, more than two pages and a half are devoted to *Drüsen*, none to *Zelle*, and only half a page to *Zell-kern*—to the light and neat English "Glossary of Botanic Terms" of our own countryman, Mr. Daydon Jackson.

The authors admit that the book has been designed to exclude antiquated terms on the one hand, and the most modern terms of the English-American and French literature on the other; they anticipate the question, "How are we to draw the line?" and have decided that all purely descriptive expressions shall be excluded. But what are we to say to a "Handwörterbuch" from which all terms belonging to biochemistry and micro-technique, &c., except a few arbitrarily selected general terms, such as "swelling," "fermentation," "catalysis," "turgescence," &c., are excluded?

That the book contains an enormous amount of carefully collected information is sufficiently guaranteed by the names of the collaborators, but it is not a dictionary in the true sense of the word, and it is a very incomplete encyclopædia. The illustrations are good, but the majority of them are old and well-worn friends transferred bodily from the text-books of Sachs, De Bary, Franck, and others. To the ordinary student in this country the book can have little value; to the expert and experienced investigator it will have sufficient attractions for him to place it on his shelves. Of course, the position it may be accorded in Germany, for the German student, is another matter with which we have nothing to do.

(2) Here we have a neatly-got-up book far more in accordance with the idea of a dictionary, though even here some of the paragraphs are too long and drawn out in the form of encyclopædic articles.

The preface begins "Vi fu chi affernio che il più interressante di tutti i libri è un dizionario." This may be so, in spite of the story—apparently unknown to the author—of the Scotchman who was found steadily perusing a dictionary from cover to cover with the sole complaint that the matter of the story seemed somewhat disconnected. A useful feature of the book is an appendix of biographical sketches of botanists, living and dead; this is necessarily very short and incomplete. There are no illustrations.

Taking these two works together, they may be recommended to the expert botanist, as said, as books of reference in cases where he wishes rapidly to extend his definition of special terms.

OUR BOOK SHELF.

First Steps in the Calculus. By A. F. van der Heyden. Pp. vi+216. (London: Edward Arnold, 1906.) Price 3*s*.

THE modest claim expressed by the author in his preface, in the hope "that a step in the right direction has been taken towards producing a text-book suitable for an ordinary class in a Secondary Day School," is a claim which it would be impossible to deny. Experience has shown that geometrical illustrations, such as those on pp. 32–34, 45, and 96, are actually of great help to beginners, and we quite agree with the author that complicated theorems, such as Taylor's expansion (when applied to any but rational integral functions), should not be taken too early. The introduction (p. 93) of Lodge's treatment of the connection between integration and summation would be good if the step where the assumption is made were clearly pointed out. But there are many points which the author might have considered more fully before issuing the book. While the sine and cosine are properly differentiated, it is surprising to find such a clumsy method employed for the tangent. In order to differentiate a power the beginner is required to swallow the usual series of terms which vanish in the limit, instead of treating the power as a product.

In one or two places, in putting the chord of a curve equal to the corresponding arc, a line of explanation, or even a reference number, would have made things much clearer. The introduction of *e* as early as chapter vi. is no doubt in accordance with traditions, but it is a pity to defer the study of the calculus until the text-books in algebra referred to for a discussion of exponential series have been read. Rational integral functions, with applications to geometry and physics, afford plenty of material for the beginner. Lastly, the questions in examples ix. are very important indeed, but they give difficulty to many students who can hardly be described as beginners. The general conclusion is that the book would be more correctly described by a title which did not suggest something so *very* elementary. It is well suited for the class-room.

A Manual of Hydraulics. By R. Busquet. Translated by A. H. Peake. Pp. viii+312. (London: Edward Arnold, 1906.) Price 7*s*. 6*d*. net.

THIS book is a translation of a French treatise on hydraulics by Prof. Busquet, of the École industrielle de Lyon. It claims to be a text-book of applied hydraulics in which complete technical theories, and all useful calculations for the erection of hydraulic plant are presented. The translator appears to have done his work well, and to have given the meaning of the author in English terms and phrases. While the same arithmetical methods used in the original have been adhered to, the dimensions have been changed into ordinary British units, and the constants given in the formulæ have been modified to suit the change. The first three chapters deal with the elementary principles of the flow of water in open channels and pipes, and the last chapter with the flow over weirs. These subjects are dealt with in a simple and practical way. They do not, however, contain any information that is not to be found in English text-books on the same subject.

The fourth chapter, which occupies about half the book, is devoted to the theory and description of hydraulic motors and engines used to transform the energy contained in a head of water into mechanical work. The use of waterfalls hitherto has been limited, because the application of the energy could only be used locally, but since electricity has come into use for the transmission of power to great distances, water has assumed a new and increased value as an economical source for the production of power, and the construction of hydraulic installations is increasing at a rapid rate. The use of water-power and the machinery required to adapt it to commercial use have received very little attention from the authors of modern English and American treatises on hydraulics.

The writer does not know of any book that deals with this subject in so practical a way as the one under notice. The several kinds of water-wheels in use are described and illustrated, and their theoretical and useful value demonstrated. Turbines, which are now being largely used for the distribution of water-power, are freely dealt with, and the merits of the different forms of this machine discussed. The book is calculated to be of service both to students of practical hydraulics and to those engaged in designing and carrying out works for the utilisation of water-power.

Guide to the Principal Families of Flowering Plants. (After Engler's System.) By J. Adams. Pp. iv+46. (Dublin: Sealy, Bryers and Walker, 1906.) Price 1*s*. net.

A CONVENIENT summary for determining the orders of flowering plants is a much required desideratum. The difficulties in compiling such a summary are very great, not the least being due to the impossibility of defining the limits in certain cases between allied orders. Mr. Adams has not attempted such details, preferring to leave out a large number of orders and to sacrifice difficult distinctions to brevity and general utility. With regard to the statement that the book is after Engler's system, this applies only to the names of the orders; the method of separation is purely artificial. Thus, in the Archichlamydeæ, parasites and insectivorous plants are first eliminated, then consideration of the vegetative organs provides the next stages in differentiation. So far as practical tests have been applied with a few orders, the tables have given quite satisfactory results.

The Extra Pharmacopoeia of Martindale and Westcott. Revised by Dr. W. Harrison Martindale and W. Wynn Westcott. Twelfth edition. Pp. xxx+1045. (London: H. K. Lewis, 1906.) Price 10*s*. net.

THIS most useful volume has now reached its twelfth edition, and extends to more than a thousand pages. The pages are small ones, but packed with information, and the paper is thin, so the volume still remains one of handy size. The book is more than its name indicates; it not only includes remedial agents which have been introduced up till now into medical practice, but contains a great deal of information regarding recent research in disease. For instance, we find an excellent summary of the present state of the cancer question, the newest methods of bacteriological investigation, and a concise statement of modern views on toxins and antitoxins, serum therapy, opsonins, and the like. No busy practitioner can afford to do without such a convenient and trustworthy *vade mecum*.

LETTERS TO THE EDITOR.

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

The Extirpation of the Tsetse-fly: a Correction and a Suggestion.

IN my letter published in NATURE of October 25 on the breeding haunts of the tsetse-fly discovered by Dr. Bagshawe, I stated that there were no banana plantations on the deserted island of Kimmi, on the Victoria Nyanza, and suggested that the flies there must have some other breeding-places than the plantations. I am informed, however, by my friend and colleague Lieut. A. C. H. Gray, R.A.M.C., who has just started for Uganda, that he and the late Lieut. F. M. G. Tulloch, when collecting flies on Kimmi, came across deserted banana plantations, overgrown by the forest and bearing ripe bananas (a sure sign that no natives visit them or know of them). I must correct, therefore, my former statement.

If the banana plantations should prove to be the sole or principal breeding-place of the tsetse-fly, the question at once arises, what means could be taken to exterminate the fly or check its increase? To destroy the plantations would be impossible, as I have said, because the banana is the staple food of the country. I venture to suggest that an efficient means of keeping down the tsetse-fly would be to encourage or constrain the natives to keep fowls in their plantations in places where the fly is abundant. These birds would scratch up and discover the pupæ much quicker than a man could, and would probably devour them greedily when found. In forest districts it might be seriously considered whether it would not be advisable to introduce the Indian jungle-fowl for the same purpose. It is, of course, always a risky thing to introduce exotic wild species into a country, but the jungle-fowl, being a valuable game-bird, could hardly be a serious nuisance, however much it multiplied.

I would suggest, further, that a most suitable place in which to try experiments on the extirpation of the fly would be the island of Kimmi already mentioned. Within easy reach of Entebbe, uninhabited, covered with forest or jungle, and swarming with tsetse-flies, it is a locality in which it would be very easy to introduce the jungle-fowl and to watch the effects. As there are no monkeys, so far as I am aware, on the island, the fowl would probably be able to flourish and multiply unchecked. Such an experiment, even if it failed to produce the desired effect, could do no harm, and if it succeeded would be of very great importance.

E. A. MINCHIN.

Lister Institute of Preventive Medicine, November 2.

The Efficiency of the Present Process of Natural Indigo Manufacture.

IN NATURE of September 20 (vol. lxxiv., p. 526) I find mention of a paper read before Section B at the recent meeting of the British Association by Mr. W. Popplewell Bloxam, on a new method of determining indigotin. It is stated that "the author concludes that the present process of manufacture is a wasteful one, the highest efficiency attained not reaching 50 per cent., whilst on the average only 25 per cent. of the indigotin in the leaves is extracted."

In justice to the indigo-planting community in India, I think this statement should not go unchallenged. The grounds on which Mr. Bloxam draws his conclusion are not given in the brief *résumé* of his paper in NATURE, and I am therefore obliged to seek an explanation in his communication to the Journal of the Society of Chemical Industry of August 15 on the same subject, in which a similar statement of the low efficiency of the indigo-manufacturing process is made. In this paper Mr. Bloxam gives the analysis obtained by his new method of the indigo turned out each day during the manufacturing season at a certain factory in Bihar. From the figure so obtained, and the total daily outturn of finished indigo recorded in the factory "mahai" book, he calculates the amount of indigotin produced day by day, and from the proportion existing between the amount so calculated and the amount theoretically obtainable, deduced from the weight of green plant placed in the vat and *the assumption that this plant contains 0·6 per cent. of indigotin*, he arrives at his estimate of the efficiency of the manufacturing process.

Now it is clear that in this method of calculation error may occur in the following particulars:—

(1) The analysis of the finished indigo.

(2) The weighment of the daily outturn of finished product.

(3) The weighment of the green plant.

(4) The assumed content of indigotin in the green plant.

The first point is one for discussion elsewhere. It is sufficient for my present purpose to point out that the average of Mr. Bloxam's results (60 per cent. indigotin) agrees substantially with the average quality usually accepted as typical of Bihar indigos, and that, therefore, his results probably do not differ very widely from the truth. The same cannot be said of the second point. Separate weighment is hardly ever made of the daily outturn of an indigo factory, and I know as a fact that this was not done in the case on which Mr. Bloxam bases his figures. A rough estimate of the outturn is arrived at by measurement of the cakes produced in a wet condition, and the result obtained generally falls short of the actual production by 10 per cent. to 30 per cent. Mr. Bloxam must therefore have obtained his figures from cake measurement—at best a very inaccurate proceeding.

Similar inaccuracies occur in the weighment of the green plant in the ordinary factory routine; but the culminating error on which Mr. Bloxam's figures are based occurs in his assumption of 0·6 per cent. as the amount of indigotin occurring in the green plant. It has been my privilege to serve the indigo planters in Bihar in a scientific capacity for nearly five years. During this time I have carried out some hundreds of analyses of indigo plants of all varieties, ages, and sizes, and in only one or two cases has so high an indigotin content as Mr. Bloxam assumes is normal been recorded. These were in cases of the Java plant (*Ind. arrecta*, which contains an exceptional amount of indigotin, and was only being cultivated on a small scale during the season from which Mr. Bloxam's conclusions are drawn) under peculiar conditions of manuring. It would be more accurate to place the average indigotin content of the plant used during the season quoted by Mr. Bloxam at 0·3 per cent., so that his estimate of the efficiency of the manufacturing process should be doubled.

As a matter of fact, recent work, carried out with attention to the details I have enumerated, has shown that the process may with care, but with no modification other than is available to every planter, be rendered as efficient as 70 per cent. to 80 per cent., and that as it is carried out by the average planter it seldom falls below 60 per cent.

C. BERGTHEIL.

The Research Station, Sirsiah, Mozufferpore, India, October 10.

The Leonid Meteors.

THOUGH the Leonid epoch of 1905 does not seem to have been marked by a great abundance of shooting stars, a magnificent aurora having unexpectedly taken the place on the evening of November 15 of the shower anticipated later on that night, yet it is probable that in the absence of moonlight and cloud the radiant in Leo would have been found to be more active than seemed to be the case. The phase of the moon renders the conditions for good observations more favourable in the present year, and it is probable that if the weather during the critical period turns out fine, Leonids will be observed in considerable numbers. In 1906 these meteors become due on the night of November 15. The anticipated display is connected by the nineteen-year period with the shower of November 14, 1868, and, like the latter, will be visible over both Europe and America. As calculated by the writer, the principal maxima take place on November 15 at 12h. 45m., 14h., 19h., and 21h. 40m., G.M.T. These maxima will therefore occur on the morning of November 16, the first two being visible here, while the remaining two, which repre-

sent by far the stronger portion of the shower, will fall to the lot of American observers.

The calculated intensity of the shower is rather inferior to that of its prototype of 1868; besides, the first maxima fall early in the night, and may not, therefore, be seen at their best. Nevertheless, the present epoch is a well-defined one, and should yield satisfactory returns to the vigilance of meteor observers.

Of the minor showers associated with the period, the most interesting occur on November 16 between 13h. and 14h., and on November 17 from 13h. to 18h.

Dublin. JOHN R. HENRY.

The Rusting of Iron.

IN reference to the discussion on the rusting of iron in recent numbers of NATURE, I happen to have a curious specimen illustrating the accumulating of rust which may possibly be of some little scientific value. It is a horse-shoe which was dug up some years ago by a child out of the sand on the site of the battle of Prestonpans, near Edinburgh. It was given me by the child's father, who was with him at the time. The shoe is now very irregular and lumpy. The thickness of the naked iron can be made out at one spot, where it is partially denuded. It is just three-eighths of an inch. But with the mass of what I can only describe as rust, and, I presume, sand—some small pebbles are, too, imbedded in it—it is in one spot as thick as 2 inches, and in girth it there measures 6⅜ inches. No part of it is wholly clear of rust; the smallest girth is 4 inches.

The famous battle was fought on September 21, 1745, and the supposition is that the shoe, if not the horse, was lost there. The supposition is probable enough. If correct, the rust would represent the accumulation in a century and a half. I may add that I have some specimens of pig-iron which were turned out at foundries here fifty years ago, and have been in the open air ever since. They have just a brown coat, but the coat is of no perceptible thickness.

JOSEPH MEEHAN.

Creevelea, Drumkeeran, October 29.

PROTOZOA AND STATOZOA.[1]

THE late publication of the first volume of this well-known series has enabled the authors to incorporate some of the results of the more recent researches upon their several subjects. Taken in conjunction with the earlier published volumes, the work seems to fulfil the purpose of providing an intelligible and adequate survey of the entire animal kingdom without giving undue prominence to particular groups.

Prof. Hartog's share in the work makes a well-timed appearance in the year which has witnessed something like a crisis in the history of protozoology. His chapters are full of suggestive comparisons and analogies, and their value is increased by the addition of copious footnotes. Some of the statements are not supported by references, as, for example, where he speaks of the presence of a contractile vacuole in the zoospores of algæ and fungi without mentioning any specific instances of this condition (p. 15).

The essential complexity of the simplest manifestations of living matter is made evident, and Prof. Hartog does not harmonise the vitality of protoplasm with the vagaries of a drop of oil or of a bubble. The segmentation of the oosperm of Metazoa and Metaphyta is compared with the sporulation of the Protista, both phenomena being characterised as brood-formations (p. 31).

In the second chapter the author begins with an interesting disquisition on the old belief in spontaneous generation as an explanation of the origin of the organisms of putrefaction, pointing out how this was due in part to the supposed inconstancy of species in Protista, and that this in turn resulted from the want of knowledge of their life-histories; how this knowledge was supplied in the first place by the Rev. W. H. Dallinger and Dr. Charles Drysdale for Protozoa, and for the Protophyta by F. Cohn and later by von Koch, who perfected the methods of culture devised by De Bary for the study of the fungi.

In his remarks on reproduction by syngamy, Prof. Hartog distinguishes between exogamy and endogamy, the rhizopod Trichosphærium affording an example of the exogamous conjugation of biflagellate isogametes, while the heliozoan Actinosphærium practises endogamy.

Referring to the pelagic foraminifer Globigerina (p. 61), the author says that after death the tests sink to the bottom of the sea to form the "Globerina ooze" (*sic*), "at depths where the carbonic acid under pressure is not adequate to dissolve the more solid calcareous matter." On the following page we read:—"Some Foraminifera live on the sea bottom even at the greatest depths, and of course their shell is not composed of calcareous matter." There is nothing to indicate to the reader why this is more obvious than any of the other plain statements in the book.

FIG. 1.—*Cerianthus membranaceus* in its tube. Colour pink, with tentacles annulated pink and brown. About 35 cm. in length. From "The Cambridge Natural History," vol. i.

The last three chapters of Dr. Hartog's treatise deal with the Sporozoa, the Flagellata, the Ciliata, and the Suctoria. As an illustration of the rapid strides of recent years, he notes that seven years ago no single species of Sporozoa was known in its complete life-cycle. It would have been better to have used the general expression "body-cavity" instead of "cœlom" on p. 105. Cœlom and hæmocœl are both body-cavities, just as clothes props and thoroughbreds are both horses!

The importance of investigations into the life-

[1] "The Cambridge Natural History." Vol. i. Protozoa, by Prof. Marcus Hartog; Porifera (Sponges), by Igerna B. L. Sollas; Cœlenterata and Ctenophora, by Prof. S. J. Hickson, F.R.S.; Echinodermata, by Prof. E. W. MacBride, F.R.S. Pp. xvii+671; illustrated. (London: Macmillan and Co., Ltd., 1906.) Price 17s. net.

histories and microchemical properties of the Protozoa, which may be said to have achieved their present culmination in the life and death of Schaudinn, is worthily presented by Dr. Hartog.

Miss Sollas's three chapters commence with a brief historical introduction, followed by a lucid description of two typical British sponges, *Halichondria panicea* and *Ephydatia fluviatilis*. The traces of a nervous system referred to on p. 39 of this volume are not to be found here. Chapter viii. concludes with a key to British genera of sponges, comprising seventy-one names, and chapter ix. deals with questions of reproduction, physiology, and the formation of flints.

Turning now to Prof. Hickson's valuable contribution, we note that he treats the Cœlenterata and the Ctenophora as separate phyla instead of regarding the former as divisible into two branches, the Cnidaria, those which are armed with stinging threads, and the Ctenophora, those which are provided with swimming plates. A more serious change which he has introduced is the resolution of the old order Hydrocorallina into two distinct orders, Milleporina and Stylasterina, the former second, the latter sixth, in the list of orders, separated in the text by the Gymnoblastea, the Calyptoblastea, and even the Graptolitoidea.

With regard to the relations between the hydroid stock or hydrosome and the medusoid gonophore or medusome of the Hydrozoa, Prof. Hickson gives expression to the perennial "vexed question" as to whether the hydrosome preceded the medusome or *vice versâ*; he does not assist the reader by adducing analogous instances. The stock and sexual stolon of some annelid worms would seem to offer an almost exact analogy to the hydroid and medusoid phases of a hydrozoan; the medusome might even be regarded as an epitokous sexual phase, the stock being the parent form, indifferently whether it is fixed or free; the liberation of the medusæ (where this occurs) would correspond broadly with the swarming of the epitokes.

The general treatment of the three classes, Hydrozoa, Scyphozoa, and Anthozoa, leaves little to be desired within the limits prescribed by the nature of the work, and prominence is given to bionomical questions.

Prof. Hickson's last chapter is concerned with those wonderful creatures of the plankton, the Ctenophora. In describing the planes of symmetry of the body, the author speaks of the tentacular or "transverse" plane and of the "sagittal" plane. These animals show no antero-posterior differentiation, and only in one order, the Platyctenea, do they exhibit dorso-ventral differentiation; their symmetry is biradial, and it is undeniably inaccurate to saddle them with transverse and sagittal planes. If a comparison with higher forms must be made, there are strong reasons for the belief that the tentacular plane of the Ctenophora should be likened to the sagittal plane of Bilateralia.

In his account of the siphonophoran body (p. 298), Prof. Hickson evinces a general willingness to steer clear of wearisome polemical discussions; in this case the difficulty might have been surmounted by calling the various parts of the colony neither organs nor zooids, but organozooids.

The volume concludes with six chapters on the Echinoderms from the pen of Prof. MacBride. In the classification of the Ophiuroidea the author has followed Prof. Jeffrey Bell's system, which seems to have achieved the distinction of permanency. The tabulation of the families of Asteroidea is based upon Prof. Perrier's system, and gives a very different sequence from that based upon Mr. Sladen's orders, also in vogue at the present time. In the chapter on the Echinoidea (sea-urchins) there are interesting passages on the physiology of the pedicellariæ; the chapter on the Holothuroidea (sea-cucumbers) contains a humorous though instructive comparison between the organisation of a Synaptid and that of a Sipunculid.

The final chapter is devoted to questions of development and phylogeny. It seems probable to Prof. MacBride, and will doubtless appear so to his readers, "that Vertebrata and Echinodermata both arose from Protocœlomata." It remains to be added that the illustrations are excellent, and many of them original.

The term "Statozoa," originally applied to certain Echinodermata, but not generally adopted in that connection, may be conveniently extended so as to include such animals as sponges, cœlenterates, and echinoderms, in which a fixed condition is either actually or phyletically predominant.

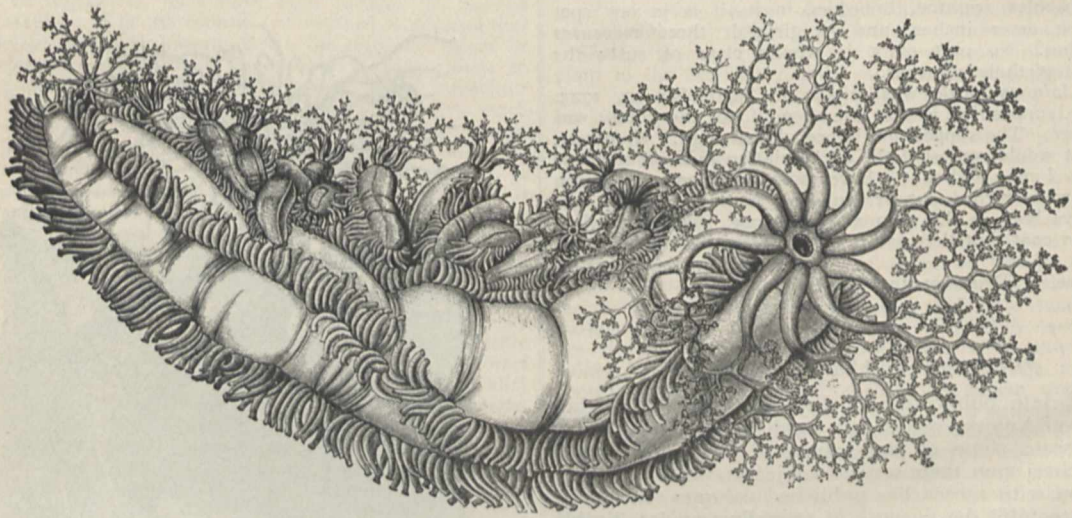

FIG. 2.—*Cucumaria crocea* carrying its young. ×1. From "The Cambridge Natural History," vol. i.

THE INTERNATIONAL GEODETIC CONFERENCE AT BUDA PEST.

THE International Geodetic Association held its triennial conference at Buda Pest from September 20 to 28, and I had the honour of serving as the delegate of our Government. By the kindness of the Hungarian Academy the meetings were held in their handsome building, and the arrangements for our reception, which had been made by M. Louis de Bodola, were in every way admirable. Before considering the scientific work of the conference I may mention that the Prime Minister, Dr. Wekerle, invited the members of the "Permanent Commission" to dinner, and that the Archduke Joseph afterwards received all the delegates at the palace. On subsequent days the Burgomeister of Buda Pest gave a dinner in our honour, as also did Count Albert Apponyi, Minister of Public Instruction.

The work of the conference was more interesting than that of any other at which I have been present, and the time was barely sufficient for the adequate discussion of many subjects of importance. In an article of this character it will clearly be impossible to do more than indicate in general terms the subjects which were considered.

The systematic observation of the variation of latitude, which is the special province of Dr. Albrecht, was naturally the subject of much discussion. The existence of a mysterious term in the expression for the position of the pole was discovered some years ago by Prof. Kimura. If this term, which is denoted by the letter z, has a real physical existence, it would indicate that the equator oscillates backwards and forwards, moving parallel to itself. It appeared that observations conducted in the southern hemisphere would quickly determine the reality of the supposed motion. Accordingly, at the conference of Copenhagen in 1903 it was resolved that observations in the southern hemisphere should be instituted, and should be carried out for a period of at least two years. The southern observations of latitude are to be made at Bayswater, West Australia, where Dr. Hessen began his observations on June 6, 1906, and at Oncativo, in the Argentine Republic, where Prof. Carnera began work on May 5. These two stations are in S. latitude 31° 55′. We also heard from Mr. Innes that latitude observations will probably be commenced at Johannesburg (S. latitude 26° 12′) by the end of the present year. With regard to the observations in the northern hemisphere, it was resolved that they should be continued, at least until the year 1909, when the next conference will meet. The northern stations are Pulkova and Leyden, and in N. latitude 39° 8′ Mizusawa, Charjui, Carloforte, Gaithersburg, Cincinnati,[1] and Ukiah, together with Tokyo in latitude 35° 39′. Prof. Helmert gave an interesting account of the present condition of the whole investigation, and he directed attention to certain oscillations or systematic errors of which the physical meaning is as yet altogether obscure. Whatever their meaning may be, their magnitudes are excessively minute.

Another report of importance was one by Dr. Albrecht on the use of wireless telegraphy for the determination of differences of longitude. He concludes that this method may be relied upon to give as good results as those derived from telegraphy through wires.

Dr. Hecker had undertaken, at the expense of the association, a second long sea voyage for the purpose of determining the value of gravity at sea. His first voyage was from Portugal to Brazil, and the second was in the Indian Ocean and across the Pacific. He presented a short preliminary report, in which he stated that the intensity of gravity for the deeper part of the Pacific Ocean is approximately normal, and agrees closely with Helmert's formula of the year 1901. His experience in the first voyage had enabled him to effect considerable improvements in the procedure. The method depends upon the determination of the temperature of boiling water and the simultaneous observation of the height of the barometer. The difficulties in attaining at sea to the requisite degree of accuracy are so numerous that it is matter of surprise that trustworthy results can be obtained. There seems, however, to be now no doubt that we may trust his conclusions. Dr. Hecker exhibited his apparatus with five barometers furnished with the means for obtaining continuous photographic records of the height. One of the greatest difficulties to be contended with is the motion of the ship, for the pitching and rolling make the mercury in the barometer "pump," and the photographic trace of the barometer height is marked with regular notches. Dr. Hecker is to be congratulated on the skill with which he has overcome this and many other difficulties. His conclusions form one of the most noteworthy acquisitions to geodetic knowledge of the last twenty years.

MM. Claude and Driencourt gave an account of the use of their prismatic astrolabe. It gave me the impression that it might be an instrument of much use to geodesists.

The measurement of base lines naturally afforded an important subject of discussion, and M. Guillaume, assistant director of the International Bureau of Weights and Measures at Bréteuil, gave an admirable account of the recent improvements which have been effected in the use of the Jäderin wires. It would appear that the measurement of base lines has now reached such perfection that we cannot look for any great advance in geodetic accuracy in this direction. Errors due to triangulation accumulate rapidly, and the modern practice is to measure short bases about every 200 miles. The Simplon Tunnel has been used by the Swiss geodesists as a base line, and was measured by the Jäderin apparatus. The railway company was good enough to surrender the tunnel to the geodesists for five clear days, and by means of continuous work day and night they were able to complete their task. A special form of tripod for supporting the wires was devised; it rolled along the railway lines, and in this way the labour of transporting the tripods was considerably diminished.

The national reports furnished by the several delegates were in many cases of great interest, but I can only refer to a few of them.

The work of the Swiss in the measurement of a base along the Simplon Tunnel has already been mentioned.

A proposal has been made for the collaboration of the French and Italians whereby the island of Sardinia may be linked to Corsica and to the Italian mainland.

The French delegates gave a final account of the measurement of the great arc of Peru. This work took five years, and eleven officers of the Service Géographique de l'Armée and twenty-eight under-officers and soldiers took part in it. Several of the staff died of exposure and hard work in the Cordillera, and the conference received this intimation standing, in token of respect to their French comrades who lost their lives in the cause of science.

I myself presented reports from Colonel Burrard, R.E., on the work in India, and from Sir David Gill, Colonel Morris, and Mr. Simms, on the geo-

[1] The observations at Cincinnati will, as I understand, be discontinued shortly.

detic survey in South Africa. The conference listened with interest to the account of the various difficulties which had been met with in Africa.

It is well known that the British South African Company, in fulfilment of the wishes of the late Mr. Cecil Rhodes, has up to the present year met all the heavy expense of that part of the survey along the thirtieth meridian of east longitude which runs through Rhodesia, but it has been found necessary for the company to effect various economies, and there was a doubt as to whether it might not prove necessary to suspend the survey for a time. Such a suspension would have proved most unfortunate, since there would have been no junction to the southward between the Rhodesian triangulation then completed as far as Gwelo and the Transvaal triangulation which begins at the Limpopo River. A surveying party under Captain Gordon, R.E., was already in the field in Rhodesia, and it was obvious that it would be much more economical to continue the work at once rather than to defer it until some undetermined time in the future. The expenditure needed for the survey from Gwelo to the Limpopo was estimated at 1600*l.*, and after various negotiations in England the British South African Company offered to advance half that sum, while the Royal Society, the British Association (from a fund raised principally in South Africa for the meeting of 1905 at Cape Town and Johannesburg), the Royal Geographical Society, and Sir Julius Wernher subscribed the other half. These negotiations had to be conducted very hurriedly in order to obviate the break-up of the surveying party, but by means of the telegraph and through the exertions of Sir David Gill all obstacles were overcome, and Captain Gordon began work in June. Since the meeting of the geodetic conference I have heard from Sir David Gill that Captain Gordon is making good progress. Thus in a few months the triangulation will be finished up to and beyond the Zambezi. With respect to Northern Rhodesia, preliminary reconnaissance has been made nearly as far as Lake Tanganyika, and I have reason to hope that, although Sir David Gill is retiring from his position as Astronomer Royal at the Cape of Good Hope, the British South African Company will make arrangements for the completion of the great scientific enterprise for which they have already done so much.

At Lake Tanganyika the continuation of the survey northward will fall to the Imperial German Government. The Academy of Sciences of Berlin has appointed a committee to consider the matter, and although Dr. Helmert was not able to announce that the work would be undertaken immediately, yet I think we may be confident that the northward progress of the survey will be continued in a year or two.

In Egypt Captain Lyons is making preparations for the geodetic survey southward, and I have no doubt that when the conference next meets substantial progress will be reported there also.

In the years 1903 and 1904 the International Congresses of Geology and of Academies passed resolutions in which they asked for the help of the Geodetic Association in respect to accurate levelling and measurements of gravity with a view of throwing light on the internal distribution of masses in the earth and on the rigidity and isostasy of the crust of the earth. It was entrusted to M. Lallemand and to me to draw up preliminary reports on these subjects. M. Lallemand, whilst admitting the importance of the requirements of the geologists, could not maintain that levelling has attained to such a high degree of accuracy as to betray small movements of the land relatively to the sea, but he thought that large changes of level could be detected, and he expressed the opinion that the lines of levelling ought to be repeated at such intervals as two or three times a century. For my part I could not think that it was possible for geodesists to undertake such elaborate measurements of the direction and intensity of gravity as would fully satisfy the requirements of geologists. The repetition of the levelling of a country and systematic observations of gravity entail great expense, and the conference seemed to be unanimously of opinion that they would not be justified at present in urging on their respective Governments any increase of expenditure in these directions. Nevertheless, the wishes of the geologists will not pass unnoticed, for there can be no doubt that in future campaigns with the level and the pendulum more attention will be paid than heretofore to the constitution of the country under survey.

Before referring to the resolution on this topic which was finally adopted by the conference, I must speak of two other communications of great importance. Mr. Tittmann, superintendent of the United States Coast Survey, and Mr. Hayford, inspector of geodetic work, communicated on behalf of the United States a very elaborate discussion of the anomalies of gravity throughout the United States. The conclusions at which they arrived are of great interest to geologists, for it was shown by Mr. Hayford that, at least in the United States, the matter constituting the earth is in hydrostatic equilibrium at a depth of about seventy miles below the surface. In technical language, this is the depth of isostatic compensation. In this connection Baron Eötvös, professor in the University of Buda Pest, explained his application of the torsion balance or Cavendish apparatus for determining local deviations from normality, both in the direction and in the intensity of gravity. His instrument, which we had the pleasure of seeing at the laboratories of the University, is of astonishing sensitiveness, and, so far as we can see at present, its indications are trustworthy. It would seem probable that this instrument might be used to give exactly those indications as to the distribution of internal masses of which the geologists are so desirous. The communication of Baron Eötvös was considered of so much importance that the conference directed special attention to it in the resolution which was adopted as an answer to the International Association of Academies. The Geodetic Association has at present no funds available for continuing researches with the torsion balance, but there is reason to believe that the Hungarian Government will continue to support Baron Eötvös in his researches. It may even become possible by measurements, say on Vesuvius, before and after an eruption, to find where the lava which is ejected from the crater has come from, since the displacement of large masses from beneath the mountain should be betrayed by the indications of the torsion balance.

This meeting of the conference is the last under the existing convention, which expires at the end of the present year, but it was announced that twenty of the Governments which have taken part in the existing convention have already entered into a new one for the forthcoming ten years. There is reason to believe that the Argentine Republic will also join. Indeed, Dr. Porro was at Buda Pest as representative of that Republic, and took part in our discussions.

A telegram has already appeared in the *Times*, and has been repeated in NATURE, stating that I have invited the conference to meet in Cambridge in the year 1909. This is incorrect. It is true that the association has never yet met in England, and I

believe that a meeting here would be of great value for British geodesy, but I told the conference that I had no power to give an invitation, which must come from the Government. I can only now repeat the expression of the hope that the conference may meet in this country in 1909. G. H. DARWIN.

THE FIRST "MANNED" FLYING MACHINE.

OCTOBER 23 of the present year will be remembered as a red-letter day in the history of flying machines, for it was on that day that the first flying machine, constructed on the "heavier than air" principle, successfully raised itself *and its driver* from the ground several feet, and transported itself by means of its own power over a distance of eighty yards.

In this his first successful flight with this machine, M. Santos Dumont is to be sincerely congratulated, for he has accomplished a performance which many workers in different parts of the world have been striving after for many years past and failed. M. Santos Dumont's machine is built on the aëroplane principle, and mounted on two wheels. It is fitted with an eight-cylinder, 60 h.p. motor weighing about 170 lb., and drives an aluminium fan, which makes 1000 to 1500 revolutions a minute. The motor is the work of the Adams Manufacturing Company, England. With its driver the machine weighs about 750 lb.

The aëroplane is shaped like a large T placed horizontally. The short arms of the T are slightly inclined upwards, and are each composed of three compartments, like three box-kites tied together side by side. At the base of the T is a large compartment, also like a box-kite, and by manipulating this about a horizontal axis the upper and lower surfaces act as a powerful rudder. This rudder arrangement is at the front end of the aëroplane, and the operator stands on a platform midway between, and nearly on a level with, the lower surfaces of the two main inclined arms. The driving fan is situated at the rear of the machine, just behind the operator, at the junction of the two main inclined arms.

Now that success has rewarded this daring investigator, it is of interest to take a cursory glance at the steps which ultimately led the way to success.

One naturally, in the first instance, calls to mind the very interesting experiments carried out in 1893 by Herr Otto Lilienthal near Berlin (NATURE, vol. xlix., p. 157), because Santos Dumont's aëroplane is, generally speaking, somewhat after the style of the gliding machines used by him. Lilienthal's experiments were confined to trying to learn soaring, and he employed slightly curved wings having a surface of about 15 square metres. With these inclined planes, and eventually vertical and horizontal rudders, he started from the top of a hill, and after a few steps forward jumped into the air and glided sometimes 250 metres. Lilienthal depended for the success of his apparatus on himself, trusting to his instinct to be able to keep his balance by making the necessary compensating adjustments by moving his own centre of gravity. In later experiments he employed some mechanical aid to assist him in sustaining himself longer in the air. This consisted of a small machine driven by compressed carbonic acid gas, and operating a series of feather-like sails which were capable of flapping. He found that occasional flapping of these wings helped him to cover longer distances.

In 1895 he adopted a new principle, and instead of using one large framework, employed two smaller ones, placed parallel one above the other; this method he found distinctly advantageous (NATURE, vol. liii., p. 300).

About this time Lilienthal's soaring experiments began to be taken up both in this country and in America. Mr. Percy S. Pilcher in England gained considerable experience both in the making and in the handling of these aëroplanes (NATURE, vol. lvi., p. 344). Unfortunately, as in the case of Herr Lilienthal, an accident during his experiments resulted in his death. Pilcher, however, was quite aware of the importance of using some motive power, and some time before his death proposed to employ, and actually began to make, a small and light engine, indicating about 4 h.p., to drive a fan, this being considered by him as more than sufficient for flights of moderate length. With this advance it was hoped that much greater distances could be covered, and a nearer approximation to a flying machine attained.

There is little doubt that if Pilcher had been spared he would soon have constructed and made use of the latest and lightest form of motor, and probably been led to use the double-decked form of aëroplane adopted by Santos Dumont.

By embodying the best ideas of his predecessors and using his own ingenuity to make the aëroplane a practical flying machine, Santos Dumont has advanced the science of aëronautics a very considerable step. The petrol motor has no doubt helped greatly in facilitating this progress, since high-powered engines of comparatively very light weight can be constructed.

In this pioneer work of navigating the air the work of Hiram Maxim and S. P. Langley must not be forgotten. Maxim made numerous attempts to drive his flying machine at such a speed that it would be lifted off the rails on which it ran, but on no occasion could it be said that this was successfully accomplished. Further, it was not known whether it would capsize or not if it was set free. Langley, on the other hand, was undoubtedly the first to demonstrate that a machine heavier than air could be made to travel in the air driven by its own power. The machines he made and launched were all "unmanned," but nevertheless much valuable information was accumulated.

This the latest achievement of Santos Dumont will no doubt give a fresh impetus to the problem of flight, and those who have the money and time have now before them a successful aëroplane that can serve as a starting point.

THE UNIVERSITY MOVEMENT IN WESTERN AUSTRALIA.

A MEETING in support of the movement for founding a university in Western Australia was held on September 7 at Perth, Western Australia. The chair was taken by Dr. J. W. Hackett, and the principal speakers included the chairman, the Right Rev. Dr. Riley, Anglican Bishop of Perth, Dr. Hill, master of Downing College, Cambridge, who is at present lecturing in Western Australia, and the Speaker of the Legislative Assembly, Mr. Quinlan. In 1904, during the Premiership of Mr. Walter James, 4000 acres of land in the vicinity of Perth were set apart by the Legislative Assembly as a permanent endowment for the University of Western Australia when it should come to be formed. The present income from this endowment is practically nil, but its future value is likely to be considerable.

Dr. Hackett in his remarks explained the general

view that the university should be to enable the youth of the country to develop their faculties to their full capacity, and to permit them to compete on even terms in the practical business of life with those outside as well as inside Australia. Dr. Hill, in a valuable contribution to the discussion, advocated the utilisation of existing institutions, the training college for teachers, the magnificent observatory, the museum, zoological gardens, law courts, and hospital, for the teaching purposes of the university, and suggested that many of the gentlemen holding Government appointments, the geologist, electrician, bacteriologist, &c., were eminently fitted to occupy university chairs in addition to their official duties. They did not require a palace for a start, but the men. In these days of change a great stone building was a disadvantage. His idea was to forget finance, and to coordinate the existing material. Ultimately a resolution in favour of the establishment of a university was carried with practical unanimity.

At present the higher education of Western Australia is in the hands of the University of Adelaide, which conducts the examinations and gives courses of extension lectures, and this system has worked well in the past, but naturally is only provisional. In addition, the Gilchrist trustees, through Dr. R. D. Roberts, of the London University Extension Board, have for the past three years contributed to the expense of sending an annual lecturer from this country to give a course of lectures in some branch of science. These lectures are eagerly attended, and now form quite a feature in the intellectual life of the State, periodically stimulating the movement in favour of an independent university. Audiences of from 1000 to 1500 are sometimes drawn. It is difficult to say whether the lecturer or his audience derive the greater benefit. Certainly a trip round the world with a course of lectures, taking one over a large part of a new continent, among the goldfields of Kalgurli, the jarrah and karri forests of the south-west, the orchards and vineyards of Armadale, is an experience fitted to make a lecturer return to his homely desk with "renewed vinegar."

The present writer recalls many a strange impression from his lecturing experience in Western Australia; a wine neither a hock, a claret, nor a madeira, something of each, but better than all; a third-class sleeping carriage on a narrow-gauge, single-line railway, not yet to be found on our boasted Scotch expresses; gold in sight in the wall-face of one working not yet worked, estimated of the value of half a million sterling; a water scheme for supplying the mines, pumping a million and a half gallons daily over a watershed of 1500 feet a distance of 300 miles, in which the water spends six weeks in the pipes before reaching its destination; a camel, the only need of which in the desert is a weekly drink of water costing, maybe, 30*s.*; a criticism of the last night's lecture scribbled in pencil at the bottom of one mine, and delivered to the lecturer in the next without coming nearer the surface than 1200 feet; a rabbit which survived two summers of drought without water; and a clergyman who took for his text "Radium."

In wishing the university movement well in Western Australia, one may express the hope that it will still continue its policy of inviting outside lecturers to come and learn as well as to teach, and that many professors without portfolios may be induced to visit its shores in the future, to carry back with them an idea of a developing outside world which in the cloistered seclusion of a university is in danger of slipping from the memory.

F. S.

NOTES.

THE following is a list of fellows who have been recommended by the president and council of the Royal Society for election into the council for the ensuing year:—*president*, Lord Rayleigh; *treasurer*, Mr. A. B. Kempe; *secretaries*, Prof. J. Larmor, Sir Archibald Geikie; *foreign secretary*, Mr. Francis Darwin; *other members of the council* (the fellows whose names are printed in italics are not members of the existing council), *Lord Avebury, Sir Benjamin Baker, K.C.B., Dr. H. F. Baker*, Prof. J. Norman Collie, Prof. Wyndham R. Dunstan, *Prof. David Ferrier, Prof. Sydney J. Hickson*, Sir William Huggins, K.C.B., Prof. E. Ray Lankester, Mr. H. F. Newall, *Dr. Alexander Scott, Prof. A. C. Seward, Prof. W. J. Sollas*, Prof. E. H. Starling, *Prof. Silvanus P. Thompson*, and *Dr. A. D. Waller*.

THE Royal Society's medals have this year been adjudicated by the president and council as follows:—the Copley medal to Prof. Elias Metchnikoff, for the importance of his work in zoology and in pathology; the Rumford medal to Prof. Hugh Longbourne Callendar, for his experimental work on heat; a Royal medal to Prof. Alfred George Greenhill, for his contributions to mathematics, especially the elliptic functions and their applications; a Royal medal to Dr. Dukinfield Henry Scott, for his investigations and discoveries in connection with the structure and relationships of fossil plants; the Davy medal to Prof. Rudolf Fittig, for his investigations in chemistry, and especially for his work in lactones and acids; the Darwin medal to Prof. Hugh de Vries, on the ground of the significance and extent of his experimental investigations in heredity and variation; the Hughes medal to Mrs. W. E. Ayrton, for her experimental investigations on the electric arc, and also upon sand ripples. The King has approved of the award of the Royal medals. The medals will, as usual, be presented at the anniversary meeting on St. Andrew's Day (November 30). The society will dine together at the Whitehall Rooms on the evening of the same day.

Two events during the past few days have shown that men of science recognise the ability of women to originate and carry out scientific research and inspire others with their spirit. One is that on Thursday last the Royal Society awarded the Hughes medal to Mrs. W. E. Ayrton, for her experimental investigations on the electric arc and also upon sand ripples; and the other event is the first lecture delivered at the Sorbonne on Monday by Mme. Curie, who has succeeded the late Prof. Curie in the chair of general physics of the University of Paris. Both Mrs. Ayrton and Mme. Curie originated and carried out their scientific investigations unaided, and the tacit acknowledgment just made of their creative capacity—essential to work of this kind—is interesting and significant. Though some of Mrs. Ayrton's experiments on the electric arc were made in the laboratories under Prof. Ayrton's charge at the Central Technical College, it was to her alone that the conception and carrying out of the experiments were due, as well as the original speculations deduced from the results. The Royal Society, by placing Mrs. Ayrton's name alone, and not bracketed with that of a man, in the list of medallists for this year has manifested its recognition of individual work by a woman. The Davy medal was awarded by the society in 1903 to Prof. Curie and Mme. Curie jointly, for their researches on radium, though the published work on the subject shows that the discovery of radium was due to Mme.

Curie alone. But however this may be, it should be gratifying to those who have worked for the extension of opportunities for intellectual work by women to find that the scientific world is prepared to acknowledge merit without distinction of sex. The logical result of the action of the Royal Society and the University of Paris is that women should be eligible for election into any society or academy that exists for the purpose of extending the boundaries of natural knowledge.

A MEETING of the executive committee of the British Science Guild was held at the rooms of the Royal Society on November 2, Mr. Haldane, M.P., president of the Guild, in the chair. In addition to the ordinary business, the following matters were under consideration:—a memorandum on the application of improved methods in agriculture; an interim report of a subcommittee of the Guild on the amendment of the British patent laws; the appointment of local committees of the Guild in industrial centres; and the proposed anthropometrical survey.

DR. J. GUNNAR ANDERSON has been appointed director-general of the Geological Survey of Sweden in succession to Dr. A. E. Törnebohm, who retires.

THE Swiney lectures on geology, in connection with the British Museum (Natural History), are being delivered this year by Dr. R. F. Scharff, who commenced on Monday a course of twelve lectures on the "Geological History of the European Fauna" in the lecture theatre of the Victoria and Albert Museum, South Kensington. The lectures will be given on Mondays, Wednesdays, and Fridays, at 6 p.m. Admission to the course is free.

DR. POIRIER, professor of anatomy at the Paris Academy of Medicine, has proposed the establishment of an organisation to combine the efforts of French investigators who are studying cancer. It is hoped that France will before long have an institute similar to that in connection with our Imperial Cancer Research Fund, and to corresponding institutions in Germany and the United States. Dr. Henri de Rothschild has contributed 4000*l.* to the funds of the proposed league against cancer

THE preliminary forecast of the indigo crop of Bengal for 1906 is given in the *Pioneer Mail*. It appears that owing to the competition of the synthetic dye, the area under indigo has contracted very rapidly. The cultivation is being gradually abandoned in Lower Bengal. The total area sown this year is 138,300 acres, against 170,700 acres of last year, and 223,100 acres of 1904. Of the important districts, Saran reports 62 per cent. of a normal outturn per acre, Darbhanga reports 57 per cent., and Muzaffarpur 33 per cent., while Champaran reports only 27 per cent. The estimated outturn per acre for Lower Bengal, including the minor Behar districts, is 67 per cent. of a normal crop, and that for North Behar, including Monghyr, only 42 per cent. The average for the province comes to 46 per cent., against 47 per cent. The director of agriculture, however, thinks the district officers' estimates are unduly pessimistic.

COMMANDER R. E. PEARY, who has been in the Arctic region since July, 1905, when he left New York on the steamer *Roosevelt* to make a further attempt to reach the North Pole, arrived in Battle Harbour, Labrador, on November 3, and dispatched a message announcing his return. From this it appears that the expedition wintered on the north coast of Grant Land, somewhat north of the *Alert's* winter quarters. In February the sledge party went north *viâ* Hecla and Columbia, but was delayed by open water between 84° and 85°. Beyond 85° a six days' gale disrupted the ice, destroyed the caches, cut off communication with the supporting bodies, and drifted the party due east. Journeying over ice, farthest north was reached in lat. 87° 6′, while the ice was drifting steadily eastward. The north coast of Greenland was arrived at afterwards, and by travelling along the Greenland coast the ship was regained. A sledge journey was then made to the west, and the message states that the party "completed the north coast of Grant Land, and reached other land near the hundredth meridian." Further details about the movement of the ice, and the land to the north of the hundredth meridian west of Greenwich, that is, north of the American mainland, will be awaited with interest. The most northerly point reached—lat. 87° 6′—is nearly three degrees farther north than Commander Peary attained in 1902. The Duke of the Abruzzi's expedition reached lat. 86° 33′ 49″, in long. 64° 30′ E., in 1900.

THE promise of an interesting and useful addition to the local museums in the London district has been furnished by the spirited action of the Tottenham Local Board. In 1892 the Board purchased the fine "Queen Anne" mansion known as Bruce Castle from Mr. Joshua Pedley at the price he had given for it, 15,000*l.*, toward which sum he contributed 700*l.*, in the hope that some day the house would become the home of a museum for Tottenham. The estate included twenty acres of garden and timbered land, which was soon thrown open as a public park. The idea of a museum having been grasped, many specimens and offers of aid came in from neighbours and friends. By gift, and as a result of a public subscription, several important collections were acquired. Especially worthy of mention are the long series of birds, small mammals, and insects in cases and cabinets, made by Mr. H. W. Roberts, formerly a resident in Tottenham; a collection of minerals and fossils formed by Mr. Penstone, a friend of John Ruskin; and the collections of fossils and wax models made and lent by Mr. H. E. H. Smedley. Mr. Smedley is acting as honorary curator, and has generously devoted much time and skill to getting the collections into a fit state for public exhibition. Other important gifts have been made by Mr. C. C. Knight, the Hon. Walter Rothschild, Mr. Ruck, Mr. Currie, and others. The museum was publicly opened by Mr. W. W. Lewin, chairman of the libraries committee, and Councillor Knight on October 26. Mr. Smedley is responsible for the scheme of the museum, which will embrace a purely local collection of Middlesex natural history and illustrations of ancient Tottenham, while the educational aspect will be kept well in view, including exhibitions of living animals and plants designed to encourage observation at first-hand in the field amongst the young people and school pupils in the district.

IN commemoration of the forty years' reign of H.M. King Charles I. of Rumania, an exhibition is now being held at Bucharest, where the fifth Congress of the Rumanian Association of Science also assembled during last month, and was attended by more than four thousand members. Judging from the importance of the papers read and the discussions following, there is noticeable a decided advance in the appreciation of the value of education on the part of the Rumanians. The congress was divided into ten sections, the best attended being the one dealing with educational science, numbering more than three thousand members, including university professors and teachers of all classes. Great attention was given in this section to the question of extending the

number of hours at schools prescribed for physical training and military drill. The economic science section was also well attended, and great interest was attached to the papers read dealing with the betterment of the status of the peasantry, a subject which engages the attention of all political parties of the country. The outcome of this meeting has been the inauguration of a special society, starting with above two hundred members, and having as its object the thorough investigation and discussion of the social and economic problems of Rumania. One of the characteristic features of the congress was the fact that, for the first time, the clergy, as a body, participated by forming a separate section, and among other questions discussed the scientific aspects of religious teaching. It is believed that the industrial and commercial section will grow in importance in the near future. Among the other sections in which good work was done, mention may be made of the medical, physical, and chemical sections. On the whole, more than 160 papers were read. Much credit is due for the success of the congress to the president, secretaries, and council of the association, who, through their energy and zeal, have secured a promising future for their association, in the welfare of which the King and Queen of Rumania and the Royal Family take a great interest. The next congress will be held in September, 1907, at Focsani.

CORALLINES and burrowing-sponges, illustrated by a plate reproduced from Johnston, together with an account of the abnormally grown beak of a bird (presumably a rook, although no statement to that effect is made in the text), and sundry notes and observations on natural history, form the chief zoological contents of the *Museum Gazette* for October.

THE issues of *Naturwissenschaftliche Rundschau* (published at Brunswick) for October 11 and 18 contain articles on "embryonic transplantation" (*embryonale Transplantation*) and the present state of our knowledge of the "rarer earths." Embryonic transplantation, it will be remembered, was the name given by G. Born, of Frankfort-on-Maine, to the operation of grafting portions of one young larva of a newt or frog on the body of another, whereby two-headed or double-tailed monsters were produced. In the opinion of the author, Prof. H. Spemann, of Würzburg, the continuation of such experiments would probably shed light on certain obscure biological problems. In the course of his article on the rarer earths, Dr. R. J. Meyer, of Berlin, points out that scandium, which was found in 1879 in gadolinite and euxenite, and appears never to have been seen again in that state, is the scarcest member of the whole group, if, indeed, it be rightly included therein.

To the October issue of the *American Naturalist* Mr. J. C. Herrick communicates an illustrated account of the results of his investigations into the mechanism of the dental, or "odontophoral," apparatus of the gastropod *Fulgur*, or *Sycotypus, canaliculatus*. Especial attention was directed in this investigation to the discovery of the manner in which the gastropod perforates the shells of other molluscs. The mechanism of the "radula," or dental apparatus, corresponds, in the case of this genus at any rate, to the action of a chain-saw, with the restriction that the sawing action is accomplished only during the return stroke. The buccal cartilage forms a stiff framework and a grooved passage for the radular sac and the retractor muscle of the dental ribband. The muscles for protruding and retracting the radula are of very different power, owing to the fact that, from the backward direction of the teeth, the rasping is accomplished during the return pull. The author might have added that the chain-saw action is continued during the process of feeding. The second article, by Mr. L. B. Walton, deals with the microscopic fresh-water annelids of the family Naididæ obtained at Cedar Point, Ohio.

To the October *Zoologist* Mr. R. B. Lodge contributes an interesting article on pelicans in Eastern Europe, illustrated by the reproduction of a group of *Pelecanus crispus* on an island in an Albanian river. In the case of *P. onocrotalus*, the parents have been stated to feed their young from the pouch, but in the species observed by the author the young birds were seen to thrust their heads into the parental throat much below the opening of the pouch, thus resembling young cormorants. The nests were generally in groups of six or eight, the majority mere flat rings of sticks on the ground, but a few large structures of sticks some 2 feet in height, and very similar to cormorants' nests. In a second article Mr. Harvie-Brown discusses the best method of identifying the nests of the various species of wild ducks by means of the down with which they are lined, and shows that exact observations are necessary before our information on this subject can be regarded as anything near complete. The past history of the kite in Somerset forms the subject of a communication by Mr. F. L. Blathwayt, while Mr. B. F. Cummings discusses Goldsmith's qualifications as a naturalist. In the "Notes" column Mr. Harvie-Brown is enabled to announce, from the evidence of notes and a sketch communicated by the Duchess of Bedford, that the "sea-monster" recently seen in Loch Broom, on the Cromarty coast, was almost certainly a basking-shark.

GUMMING of sugar-cane plants forms the subject of Bulletin No. 3 issued from the pathological division at the experiment station of the Hawaiian Sugar Planters' Association. The author, Mr. N. A. Cobb, was the first to ascribe the disease to a bacterium; this opinion has been confirmed, and the organism has received the name of *Bacterium vascularum*. Diseased plants can be detected by the presence of dwarfed shoots bearing narrow, dried-up leaves; also on cutting the stems gum oozes out of the fibres, thus furnishing a convenient means of testing sets intended for propagation. Some varieties were found to be immune to inoculation, and it has been suggested that immunity is correlated with acidity of the sap.

A FIFTH instalment of new or noteworthy Philippine plants identified by Mr. E. D. Merrill forms supplement iii. to the first volume of the *Philippine Journal of Science*. *Pachycentra formicana*, an epiphytic shrub forming a new species of a Malayan genus, is characterised by bulb-like roots inhabited by ants; *Sundra supa*, a leguminous tree, yields timber serviceable for naval construction, and an oil suitable for making paint and varnish. Several new species of Loranthus are reported, also an Anthoxanthum similar to sweet-scented vernal grass, and a Poa related to *Poa pratensis*. The writer has drawn up two lists of plants, the one illustrating the floral relationship between the Philippines and the Celebes, the other showing the northern element in the Philippine flora.

THE curator of the botanic station in Dominica refers in his annual report for 1905–6 to the large demand, constituting a record, for young plants, the chief requests being for cacao and lime plants; a considerable number of budded orange plants, mostly of the Washington navel variety, was also supplied. In the matter of

manurial experiments with cacao, now extending over four years, a most striking result is noted for the plot mulched with grass and leaves, from which the yield per tree is higher than from the plot manured with phosphate, blood, and potash, and 77 per cent. higher than from the unmanured plot.

A SERIES of new African species of plants determined by various authorities appears as "Diagnoses Africanæ, XVIII.," in No. 7 of the *Kew Bulletin*. A Cissus collected by Mr. Dawe in Uganda is morphologically interesting on account of its bearing so-called "pearl-glands" that are regarded as food-bodies for ants. Mr. G. Massee contributes descriptions of a few new fungal species from the Gold Coast and elsewhere, as well as an article on potato-leaf curl. This disease is perpetuated by mycelium in the tubers or by conidia in the soil; it is also noted that the same disease occurs on tomatoes. An article by Mr. W. J. Bean relative to a visit to famous Scottish gardens furnishes a good account of the trees, especially conifers, that have been successfully grown in this northern, but by no means rigorous, climate.

WE have received from the Biological Laboratories, Massachusetts Institute of Technology, "A Statistical Study of Generic Characters of the Coccaceæ," by C. E. A. Winslow and Anne F. Rogers. A number of characters, such as average dimensions, manner of grouping, staining reactions, vigour of surface growth, acid production in dextrose and lactose broth, formation of nitrites and ammonia in nitrate solution, and chromogenesis, were determined for 500 cultures from various habitats, and tables are given showing the frequency distributions for single characters and pairs of characters. These tables indicate with great clearness the extreme variability of the Coccaceæ, and the impossibility of laying down hard and fast boundaries for the classification of individuals. At the same time, the authors show that certain natural types are apparent when the characters of the aggregate, and not of the individual, are considered, *e.g.* the relative frequencies of different forms of grouping, the reaction to Gram stain, the vigour of growth, the rapidity of formation of nitrites or ammonia, and the most frequent colour of the pigment formed. On the whole, they find that the last-named character is of most importance, and most highly correlated with other characters. The work is an interesting application of statistical methods (of a very simple kind) to the difficult problem of the classification of the bacteria.

THE October number of *The Central*—the Central Technical College Old Students' Assosociation magazine—includes an interesting illustrated article by Mr. Bernard Dunell on suction gas for marine propulsion. Mr. Dunell describes Messrs. Thornycroft and Co.'s efforts in the direction of a satisfactory gas-propelled barge, and also of a launch, and the results which have been obtained. The writer then goes on to describe some novelties in the construction of the engine frame and in the method of connecting the cylinder trunks to it, the object being to do away with heavy bolts, and also to make the operation of disconnecting the cylinder head as simple and as quick as possible. On the question of fuel, for engines up to 250 horse-power anthracite or coke is used, the reason being that a cleaner gas is obtained more readily and with a simpler apparatus than is possible with bituminous coal. The writer states that Messrs. W. Beardmore and Co. are just completing two marine gas engines and producers of 500 horse-power and 1000 horse-power respectively, and in these cases ordinary bituminous coal will be used. The results on these large units will be awaited with interest both from the coal point of view and also from the "gas *versus* steam" for marine work. Mr. E. Mann Langley's contribution on electric train lighting deals with a subject of which in a general way very little is heard. Although the electric lighting of trains is now taken as a matter of course, so little is known about it that the author's description of the present-day methods of the generation, regulation, and the switching in and out apparatus between battery and dynamo is very welcome. Other papers in the same issue, on the evolution of the incandescent electric lamp, by Mr. A. S. E. Akerman, and single-phase electric traction, by Mr. L. Calisch, are of interest, the former especially as giving a description of the "Linolite" lamp.

WE have received from Messrs. A. Guinness, Son and Co., Ltd., of Dublin, a copy of part ii. of vol. i. of the Transactions of the Guinness Research Laboratory, printed for private use. The principal researches carried out at the laboratory, of which Dr. Horace T. Brown is director, and published in this part, are an exhaustive investigation of the nitrogenous constituents of malt which are soluble in water, and a study of the water-soluble polysaccharides of malt.

A REPRINT has been received of a lecture on "The Early Use of Iron," delivered by Mr. Bennett Brough before the Iron and Steel Institute at Glasgow in March, and published in No. 1 of the journal of the institute (pp. 233–253). The lecturer summarises recent investigations of the earliest records to be found of the use of the metal. An interesting account is given of the use of iron in ancient Egypt, Syria, India, and Europe, and of primitive methods of working iron which still survive in India and among the negro races of Africa.

THE Nobel lecture for 1906, delivered by Prof. Philipp Lenard on May 28 before the Royal Swedish Academy of Sciences, has been published under the title "Ueber Kathodenstrahlen" by the firm of J. A. Barth, of Leipzig (pp. 44, price 1.20 marks). It contains an admirable historical account of the development of our knowledge of kathode rays and allied phenomena, from the time of the early experiments of Crookes in 1879 to the present day. The most important stages in the investigation of the rays are clearly defined, and the story of the growth of the modern electronic theory of matter is told in a manner at once comprehensive and free from technicalities. The account given by Lenard of the genesis of his own experiments in this field is of no little historical value. A useful chronological review of the literature, comprising in all fifty-five papers, published between 1860 and 1906, is appended.

AN investigation of the dimorphism of calcium and barium carbonates has recently been described by H. E. Boeke in the *Zeitschrift für anorganische Chemie* (vol. l., pp. 244–8, August 31). It is shown that barium carbonate when heated in an atmosphere of CO_2 exhibits a sudden arrest of temperature at 811°. This temperature, which varies only by a degree or two when the rate of heating is altered, represents a true inversion-point for the dimorphous carbonate. The reverse change takes place less readily, but is accompanied by a marked liberation of heat; when cooled rapidly the arrest-point was as low as 761°, but slower cooling showed an arrest at 795°, approximating towards the temperature of the sharply-defined arrest-point in the heating curve. In the case of

calcium carbonate there is a fairly definite temperature, 470°±3° C., at which arragonite passes into calcite, but the change in this case is not reversible, and even at low temperatures calcite appears to be the stable, and arragonite the labile, form.

MESSRS. F. DARTON AND CO., Clerkenwell Optical Works, have sent us a copy of the latest issue of their list of electrical novelties. The catalogue may be commended to the attention of those who are interested in the application of electricity to domestic, medical, and other purposes.

MESSRS. F. E. BECKER AND CO., Hatton Wall, London, have submitted for our inspection a specimen of their "Nivoc" patent stencil. The stencil is designed to assist young students of science in making drawings of apparatus, and will be found of service for this purpose. At the same time, the adoption of stencils of this kind will deprive pupils of the practice necessary to enable them to develop the power of rapid, unaided sketching which, as Huxley long ago pointed out, is essential to the student of science.

A SECOND edition of Prof. A. E. H. Love's "Theoretical Mechanics. An Introductory Treatise on the Principles of Dynamics," has been published by the Cambridge University Press. The first edition of the work was reviewed at length in our issue for June 23, 1898 (vol. lviii., p. 169). It is only necessary to state that the changes which have been made in the present edition are, for the most part, of the nature of a re-arrangement of the order of the material. The consequence is that the theory has been presented in a less abstract fashion, and long preliminary discussions have been avoided.

A SECOND edition of the late Prof. P. Drude's "Lehrbuch der Optik" has just been published by Mr. S. Hirzel, Leipzig. The text has been revised, and forty pages have been added to the book in order to bring under consideration the work in magneto-optics and related subjects done since the original edition appeared six years ago (see NATURE, October 18, 1900, vol. lxii., p. 595). The manuscript of the new edition was completed and partly printed before Prof. Drude's lamented death, but Mr. F. Kiebitz has seen it through the press. The work has now an index.

THE twelfth volume of the new series of the *Reliquary and Illustrated Archaeologist* has now been published by Messrs. Bemrose and Sons, Ltd. It consists of the four quarterly numbers issued during the present year. The first of these parts includes a contribution by Mr. J. Patrick to the series of papers dealing with the sculptured caves of East Wemyss, in which the Factor's Cave is described. The April number contains an illustrated article by Mr. R. Quick entitled "Notes on the Evolution of the Means of Transport by Land and Water." The most primitive means of transport by land is stated to be by means of tent poles and skin tents, but it would be hard to prove that this method was primitive either in time or in culture, especially as the author credits "prehistoric man" with "a conveyance of logs of wood bound together by withes and carried in the hand, somewhat in the manner of the Chinese sedan chair." The July number includes two interesting papers by Mr. J. Charles Wall on Lastingham; one, "Pure Norman," describes the unique example of a pure Norman crypt, free from any intrusions of later architecture, and the other, "Lastingham Relics," tells of some of the treasures, mainly the sculptured stones, to be found in the crypt. The concluding part is perhaps of less interest to the man of science. It contains, with other papers, an account by Charlotte Mason of the characteristics of Blythburgh and its church, and a short paper by Sophia Beale on the evolution of the ancient lamp.

OUR ASTRONOMICAL COLUMN.

THE CALORIFIC RADIATION OF THE SUN.—Further results relating to the intensity of the solar calorific emissions are published in No. 17 of the *Comptes rendus* by MM. Millochau and Féry. Using the instrument described in their former note, and considering only the centre of the solar disc, they obtained measures at Meudon (altitude=150 m.), Chamonix (altitude=1030 m.), and the summit of Mont Blanc (altitude=4810 m.). Accepting the emissive power as being equal to unity, these gave 4820°, 5140°, and 5560°, respectively, when standardised by the electric furnace. All these measures were obtained when the sun was near the zenith, and the observers give a table showing the hourly variation of the apparent temperature from 8 a.m. to 6 p.m.

The maximum observed temperature on the summit of Mont Blanc was 5590° absolute, and, roughly correcting for the atmospheric absorption, this gives the final result as 5620° absolute.

THE SYSTEM OF 61 CYGNI.—In No. 4128 of the *Astronomische Nachrichten* Prof. Barnard discusses a series of measures of the double star 61 Cygni which he made on 144 nights between August 7, 1900, and November 12, 1904. These measures were undertaken for the purpose of testing Dr. Wilsing's hypothesis as to the existence of an unknown dark body in the system of this star. This observer found that his photographic measures indicated an apparent periodic oscillation, in the distance between the two components, of about $0''.3$, taking place in twenty-two months. If this oscillation were real its effect on the measures of the parallax of this star would be considerable, and might account for the large differences already obtained by various observers.

Prof. Barnard's results do not, however, confirm the hypothesis, although the observations extended over twice the interval of Dr. Wilsing's supposed period. The distance between the two components does not appear to be affected by any periodical variation, and only in one case does the distance difference exceed the mean by so much as one-tenth of a second of arc. It seems evident, therefore, that some cause other than that of a disturbing body will have to be found for the differences observed by Dr. Wilsing.

THE CAPE OBSERVATORY.—In his report of the work performed at the Cape Observatory during the year 1905, Sir David Gill states that the two underground azimuth-marks of the new transit circle are now working satisfactorily, and that the observations with this instrument show a systematic diurnal variation of azimuth amounting to about +0·02 second. When the observations of circumpolar stars are sufficiently discussed to determine the absolute variation of the azimuth-marks, it seems possible that these may prove sufficiently stable to permit of the determination of the horizontal component of Prof Chandler's change of latitude. The automatic arrangements for regulating the pressure and temperature inside the sidereal clock-case are now perfect, the temperature never varying from 75° F. by more than one-tenth of a degree. The work for the Astrographic Chart and Catalogue was nearing completion at the end of 1905, and during that year 148 catalogue plates, containing 1944 standard and 112,086 other star images, were measured.

MINOR PLANETS.—In No. 4128 of the *Astronomische Nachrichten* Dr. Bauschinger publishes the numbers which have been allotted to the recently-discovered minor planets. From this list we see that the total number, up to June 21, 1906, was 601, and that thirty-two new ones were discovered between July 30, 1905, and that date, mostly at the Heidelberg Observatory. The same publication also contains a list of the names allotted to various minor planets between No. 459 and No. 562.

DESIGNATIONS OF NEWLY-DISCOVERED VARIABLE STARS.—The permanent designations allotted to recently-discovered variable stars by the Commission of the A.G. Catalogue of Variable Stars are published in No. 4127 of the *Astronomische Nachrichten*. The table given also shows the position for 1900, the precession corrections, and the range of magnitude of each object.

THE BOLOGNA OBSERVATORY.—We have received from the director of the Bologna Observatory, Prof. Rajna, an interesting account of the history of the observatory, of its present condition, and of a projected re-establishment on a new site. Founded in the year 1712, the observatory was a prominent one in the astronomical world at that time, but at the end of the eighteenth century a decadence set in, and, with the exception of the period 1855–1865, when Respighi was director, has continued ever since. The instruments are out of date or incomplete, and the only work prosecuted is the computation of ephemerides. Prof. Rajna has, however, elaborated a scheme whereby the observatory might be installed in an existing building and re-fitted with new instruments at an estimated cost of about 147,000 lire (about 5800*l*.), and to this end appeals for help in carrying out his project.

RESEARCH IN INDIA.[1]

IT must be confessed that the Englishman at home takes little interest, other than political, in his Indian Empire. The fact has been noticed by the Hindus themselves. We do not compare favourably with the Dutch, for example, who are keenly interested in every aspect of their possessions in the East. Yet the scientific importance of India (a big slice of the globe comes under the name) is in many ways unique, and to the sympathetic and imaginative mind its varied yet homogeneous population supplies an inexhaustible fund of suggestion for the study of man. Much has been done, sporadically, since the days of Sir William Jones, but scientific research in India has never been adequately organised. The antiquities and languages of India have received comprehensive attention, but the most remarkable religion of the world has depths still unfathomed; the institutions and social habits of the people are not yet fully understood; important documents, like the Tantras, still remain untranslated, though the task is a simple one, and its results would be of great value. Meanwhile the Hindus are the people who, thousands of years ago, said—as some think—the last word on philosophy. It is curious to note how frequently the European thinker ends his course in some system long ago familiar to the Hindu. "The immobility of the East," so strangely contrasting with our feverish civilisation, may perhaps contain the solution of a problem which still perplexes us—how to live.

The memoirs here noticed represent a varied range of research in biology, ethnology, the history of science, palæography, and religion, in which Englishmen, Mohammedans, Hindus, and a Belgian Jesuit have taken part. Mr. G. Muhammad gives new data on the customs and traditions of the people of Gilgit, a dependency of Kashmir, where polo is the national game and a noble family exists claiming descent from Alexander the Great. These people, as others of the Hindu Kush, possess a harvest ceremonial of great interest, and the present paper gives some well-arranged additions to Sir George Robertson's account of the subject.

[1] *Memoirs of the Asiatic Society of Bengal*, 1905-6. Vol. i. No. 1, pp. 1–23, "On certain Tibetan Scrolls and Images lately brought from Gyantse," by S. C. Vidyābhūṣaṇa. No. 2, pp. 25–42, "Sal-ammoniac: a Study in Primitive Chemistry," by H. E. Stapleton. No. 3, pp. 43–45, "The Similarity of the Tibetan to the Kashgar-Brahmi Alphabet," by A. H. Francke (with 5 plates). No. 4, pp. 47–70, "Alchemical Equipment in the Eleventh Century, A.D.," by H. E. Stapleton and R. F. Azo (with 1 plate). No. 5, pp. 73–84, "Malaysian Barnacles in the Indian Museum, with a List of the Indian Pedunculata," by N. Annandale (with 1 plate). No. 6, pp. 85–91, "Ashrafpur Copper-plate Grants of Devakhadga," by G. M. Laskar (with 1 plate). No. 7, pp. 93–127, "Festivals and Folklore of Gilgit," by Ghulam Muhammad. No. 8, pp. 93–119, "Notes on the Bhotias of Almora and British Garhwal," by C. A. Sherring. No. 9, pp. 121–181, "Religion and Customs of the Uraons," by P. Dehon, S.J. (Calcutta, 1905 [1–5, 7]: 1906 [6, 8, 9]). (Price:—1, 2*s*. 3*d*.; 2, 1*s*. 6*d*.; 3, 2*s*. 10*d*.; 4, 2*s*. 3*d*.; 5, 2*s*. 3*d*.; 6, 10*d*.; 7, 2*s*. 10*d*.; 8, 2*s*.; 9, 2*s*. 10*d*.

The paper on the Bhotias tells us a good deal about a little-known people. Their culture is partly Hindu and partly Tibetan. With the exception of the Jethoras, they are tradesmen by instinct and education. The system of "house-connections" was their business method, until the treaty of Lhasa in 1904 changed the conditions of trade. The national institution of the *rambang*, or village club, presents features of importance for the study of similar customs. In their marriage ceremonies there is a mock capture of the bride. The distinction between children and adults is marked, in language and custom, by the permanent teeth. After the burning of a corpse a bone is taken from the pyre and placed with much ceremony in what are known as "ghost-boots," while advice is given to the departed spirit as to the road he has to take.

The most considerable of these papers is that by the late Father Dehon, S.J., a missionary who knew the Uraons well. He might have compiled a valuable monograph on the people with whom he had worked for so many years had he lived. His notes reveal a liberal and scientific mind, and contain much new and already elaborated information to supplement Dalton and Risley. The Uraons or Oraons are one of the most interesting branches of the so-called Dravidian race. One or two details will show what the reader may expect to find in the paper. More than evil spirits they fear the evil eye and the "evil mouth," and the *palkhausna* rite to obviate the evil results of envy is in constant use. Father Dehon is particularly complete and lucid in his account of their theistic and spiritualistic beliefs. Each dead man has two shades, a light and a heavy; the latter goes to *Markha* (heaven), the former remains among the living. Their ancestor-worship is full of pathos and affection. Human sacrifice, the author assures us, still occurs, in spite of the vigilance of the authorities. Waifs and strays, tramps and strangers, are the victims, and the object of the sacrifice is to promote the success of the crops. The susceptibility of these natives to hypnotic influence is remarkable, and considerable use of this peculiarity is made in their religious practices. We are even told that "in a Mission School in Chota Nagpur, every time the boys sang and beat the *tomtom* together they constantly fell into trances and would run like rats along the rafters of the school, and do all kinds of wonderful things." In the *dhumkuria*, or dormitory, in which the village boys sleep, there is an organised system of bullying, the object of which is to make them hardy members of society. What would our educationists say to this? The *panch* is the whole community represented by the older members, and forms their republican chamber. There is a proverb, repeated on all important occasions, "above God, below the *panch*."

Two papers owe their material to the late Tibetan expedition. Some Tibetan scrolls from Gyantse contain interesting accounts of Buddhist saints, but do not seem to add anything new. Mr. Francke argues that the beautiful Tibetan script is derived from the Kashgar Brahmi characters. To one whose acquaintance with the ordinary Devanāgarī Sanskrit alphabet is but recent, the author seems to make out a good case for his theory.

Mr. Stapleton's study in primitive chemistry is extremely interesting. He traces the connection between savage magic and mediæval alchemy, with special reference to the process of obtaining sal-ammoniac from burnt hair. His other paper, with Mr. Azo, deals with the materials and apparatus of alchemy in the eleventh century, and is worth the attention of chemists who are interested in the origins of their science. It is chiefly written round an Arabic book. *Inter alia*, he shows that importance was attached to weights in chemical experiments 700 years before the time of Black and Lavoisier.

Marine zoologists will find new examples of Pedunculata described and illustrated in Mr. Annandale's paper. The Ashrafpur copper plates reveal the existence of a hitherto unknown line of Buddhist kings in east Bengal.

There are some good plates in the volume. The press-correcting is at times annoying; there are too many misprints, and it is confusing to find two papers each commencing on p. 93, one ending on p. 119, the other on p. 127, while the succeeding paper begins on p. 121.

A. ERNEST CRAWLEY.

NATURAL HISTORY IN NATAL.

WE have the pleasure of congratulating the trustees, and the colony generally, on the appearance of the handsomely illustrated report mentioned below,[1] which inaugurates what is practically a new era as regards scientific progress in Natal. As the museum was only opened to the public on November 30, 1904, the report is devoted almost entirely to an account of the building and the condition and extent of its collections at that date. It is, however, satisfactory to learn that, under the direction of Dr. E. Warren, the institution is already of considerable educational value to the colony, and that it promises to be still more so in the near future. One of the questions which, as in all such cases, exercised the minds of the authorities at starting was whether the museum was to be solely devoted to local exhibits or was to contain a representative general series. So far as zoology is concerned, the question has been decided in favour of the latter alternative, and it has been also settled that local and foreign specimens are in the main to be exhibited in one series. Whether these are the most satisfactory conclusions it is not for us to say, but we may at any rate welcome the announcement that the antelopes and other ungulates, which form the most striking—and at the same time a fast disappearing—feature in the South African fauna, are to have a separate gallery for their display. Good progress has already been made with this portion of the collection, and, if we may judge by a photograph of one portion of the "ungulate room," the mounting of the specimens, as exemplified by a group of waterbuck, and the ample amount of case-room provided, will render this part of the collection as attractive and striking as its representative in our own Natural History Museum. We are glad to see that the example set by the latter institution of mounting the specimens either on artificial ground-work or on earth-covered (in place of polished sycamore) stands, has been adopted by the director, and we may express the hope that no efforts will be spared to render this series as complete as possible before it is too late.

As regards the educational function of the museum, it was decided to defer the establishment of lectures and classes until such time as a special commission had finished its sittings and issued its report, but it is proposed that the institution should eventually take its share in a large scheme of technical education in such subjects as zoology, botany, and geology.

In issuing a new scientific serial under the title mentioned below,[2] the authorities of the Natal Museum are undoubtedly doing good service to the cause of biology and geology throughout the world, more especially as one of its great features is the full and sufficient illustration of the new species from time to time described. In this latter respect the trustees are setting an excellent example of wise liberality, for one of the crying evils of the present day is the continual flood of descriptions of alleged new forms with inadequate or no pictorial illustrations. By means of the large number and superb execution of the plates accompanying the issue before us naturalists will be able to form their own opinions of the validity of the new species described, and it is sincerely to be hoped that no financial conditions will be allowed to bar the maintenance in succeeding issues of the high standard adopted in the first number. There appears, however, to be every reason to hope that the present standard will be maintained, as it is stated in the introduction that such is the express wish of both the trustees and the publishers. It is expected that about two parts (of variable size) will be published yearly. From the number of illustrations, the price is naturally somewhat high (10*s*. in the case of the present issue).

The editor has been fortunate in securing for his opening article a communication on South African fishes, in the course of which Mr. C. T. Regan describes a new South African beaked shark, differing from typical species of Pristiophorus in possessing six, in place of five, gill-slits. This difference is regarded by the author as of generic value, and the new generic term Pliotrema is accordingly proposed. Several other new fishes are described and illustrated by Mr. Regan. With the exception of one on the abnormally elongated and spirally twisted hoofs of an African sheep, the other articles are devoted to invertebrates. Mr. E. A. Smith, for instance, contributes a list of South African marine molluscs, lengthened by the addition of some new species of his own; while other writers discourse on Natal zoophytes and divers other representatives of the African marine fauna, and the editor describes a "Myxosporidium" from an African rotifer.

Once more we repeat our sense of the obligations under which biologists and geologists are placed by the liberal and progressive policy of the trustees of the Natal Museum.

R. L.

1 "First Report of the Natal Government Museum, for the Year ending December 31, 1904." Pp. 185; illustrated. (Pietermaritzburg: P. Davis and Sons, 1906.)

2 "Annals of the Natal Government Museum." Part i., June, 1906. (London: Adlard and Son.)

WEIGHTS AND MEASURES REGULATIONS.[1]

UNDER the Weights and Measures Act, 1904, the Board of Trade is required to make regulations with respect to weights, measures, and weighing and measuring instruments used in trade. These regulations, when made and laid before Parliament, are to be of general application throughout the United Kingdom, and will have the force of an Act of Parliament. The Board of Trade has accordingly prepared a code of regulations, which are, however, at present in draft form only.

These new regulations are a considerable improvement on the various local codes which they are intended to replace on January 1, 1907. They are much more definite and more readily understood than the somewhat oracular Model Regulations of 1890. The principal innovations are the abolition of cased weights, a requirement that pewter measures shall contain at least 80 per cent. by weight of tin, the restriction of the linear dimensions of dry measures of capacity to certain specified limits, the prohibition of wooden measures turned from the solid block, and the exclusion of counter weighing machines constructed on the accelerating principle. All these are steps in the right direction, and it is not anticipated that they will entail any injustice either to manufacturers or tradesmen.

A provision which will possibly meet with some objection is clause 23, which requires that the weighing instruments used by chemists and tobacconists shall satisfy the requirements of class A. This regulation, in conjunction with No. 87, would appear to prohibit these traders from using counter weighing machines and to require them to use either beam-scales or balances. There may be some exemption for machines already in use, but the important clause (No. 19) dealing with this matter is unfortunately rather loosely worded, and admits of different interpretations. It is by no means certain, however, that this prohibition, although virtual and indirect, is not *ultra vires*, as the power conferred on the Board of Trade by section 5 (1) (*d*) of the Act relates to limits of error, not to forms of weighing machines, and would appear to be exceeded here. Bearing in mind the fact that the most vexatious regulation of the 1890 code was one which the law officers of the Crown subsequently declared to be invalid, it would be a matter for regret if the excellent series of regulations now under consideration were marred by the inclusion of any provision of doubtful legal sanction.

The limits of error tolerated do not differ much from the old allowances. As regards the tests prescribed by the department under section 5 (1) (*c*) of the Act, the mode of applying these might be more precisely defined. For instance, a 1 lb. balance is required to be correct within 0·2 grain, and unless the inspectors are to be provided with standard weights of unusual accuracy it would be only fair to prescribe strictly the method of testing to be observed in such a case. The regulation on this subject (No. 85) appears somewhat vague.

In framing these proposed regulations the Board of Trade has had the advice of a committee of experts presided over by Mr. W. R. Bousfield, K.C., on which the department was represented by Major P. A. MacMahon, F.R.S.

1 "Draft Board of Trade Regulations with respect to Weights, Measures and Weighing Instruments." (London: Wyman and Sons, 1906.)

THE INTERNAL ARCHITECTURE OF METALS.[1]

IT has been cynically remarked that to deliver a successful scientific lecture to a cultured audience it is necessary to divide the lecture into three parts. The first part should be understood both by the audience and the lecturer; the second part by the lecturer and not by the audience; and the third part neither by the audience nor by the lecturer.

If the foregoing dictum were true, the speaker found himself in a paradoxical position. The object of the discourse was to make the subject under consideration as clear as possible throughout, hence the more nearly this object was achieved, the more unsuccessful the lecture. The title of the discourse might seem to some far-fetched, since, superficially, a bar of polished brass or steel apparently presented the archetype of a homogeneous solid. Any such idea, however, must in a few moments be dispelled. Taking a section of pure gold, or at any rate of gold of a purity of 99·995 per cent., this, when polished and etched, presented under a low power of the microscope large allotrimorphic crystals, the etching figures of which exhibited varying orientation in different crystals. Hence (see Fig. 1) one crystal might appear black, another show the brilliant yellow of gold, and a third exhibit middle tone. All these were purely optical effects. In the

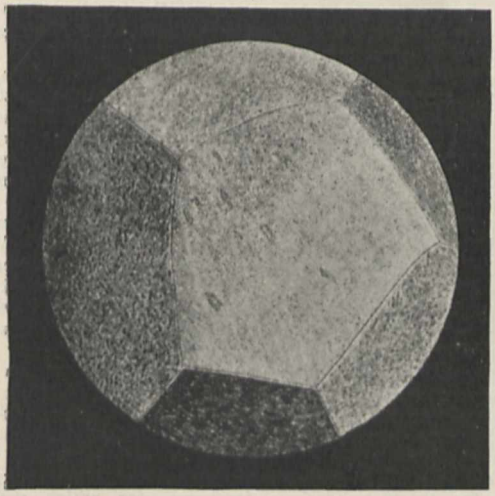

FIG. 1.—Gold.

black crystal the orientation was at such an angle as to reflect the light entirely outside the objective, whilst, going to the other extreme, the gold-coloured crystal had a molecular orientation which reflected the light entirely into the objective. It was well known that the addition of one or two tenths per cent. of the metal bismuth to gold produced a surprising mass brittleness which naturally led to the enunciation of theories to account for so remarkable a phenomenon.

Twelve years ago the theory which commanded a general acceptance, and at that time reasonably so, was that the small quantity of bismuth was incapable *per se* of producing so profound a mechanical change as to convert one of the most ductile of metals into a mass possessing an almost glassy brittleness. Therefore, the metal bismuth must act indirectly, its presence determining the maintenance of the molecules of gold in a brittle allotropic modification.

In 1896 there was published in *Engineering* from the laboratories of the Sheffield College an unambitious research recording the discovery of eutectic cements, which to a considerable extent altered the whole trend of metallurgical thought.

[1] Abstract of a discourse delivered at the Royal Institution on Friday, February 23, by Prof. J. O. Arnold.

Fig. 2 shows a micro-section of the structure of gold to which 0·2 per cent. of bismuth had been added. The microscope had at once explained the hitherto mysterious action of bismuth. It indicated clearly that the small quantity of bismuth alloyed with a definite amount of gold forming a constituent having a much lower freezing point than the main mass. Hence, when crystallisation set in during solidification from a series of centres, the "eutectic" or constituent last fluid was expelled to the exterior of each crystalline grain of pure gold, thus enveloping each crystal in a membrane of gold-bismuth alloy having a much higher coefficient of contraction than the crystal itself. Hence, during cooling, the gold-bismuth alloy, which may be regarded as the mortar of the structure, to a considerable extent detached itself from the crystalline grains of gold which may be regarded as the stones of which the mass is built up. In the micrograph, Fig. 2, the stones of tough gold are represented as white, whilst the mortar of gold-bismuth eutectic is shown as dark, thick, enveloping membranes. These membranes become pasty well below a red heat, and it was proved that at 400° C. the mass could be powdered in a mortar, the crystalline grains of pure gold becoming detached from the feeble alloy cementing them together. One of these crystalline grains exhibited no signs of the brittleness of the mass from which it was thus detached, but was readily beaten out into gold leaf in the ordinary manner.

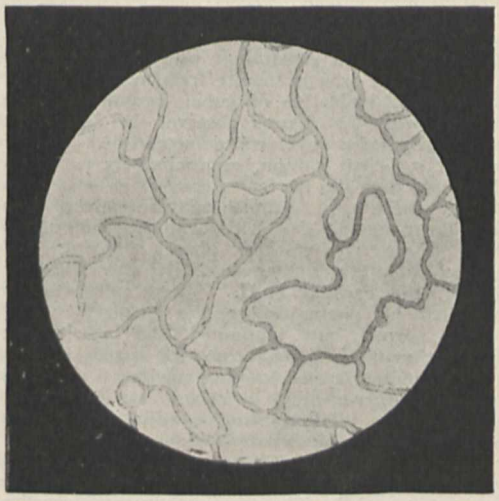

FIG. 2.—Gold containing 0·2 per cent. of bismuth.

Passing from gold to brass, it was proposed to diverge from the abstract to the concrete, and to show the value of the application of the science of metallurgy to practical problems connected with mysterious failures in marine engineering.

A notable case in point was the explosion of the brazed copper main steam-pipe of the s.s. *Prodano* in calm weather off the Kentish Knock at a pressure about one-tenth of that to which it had been previously tested. In this case the microscope was again successful in clearly indicating the nature of the electrolytic decay, under certain conditions, of brass used in naval architecture. In this connection, a familiar phenomenon is the decay of Muntz metal bolts exposed to the action of bilge water. Such bolts break suddenly, and present a distinctly coppery fracture. A micrographic examination of such bolts usually revealed a minor area of undeteriorated brass and a major area of deteriorated brass—that was to say, brass which had been more or less dezincified, an expression which meant, in other words, that the mass had become transformed into rotten, spongy copper.

Brass often consisted of two constituents, namely, a ground mass of true brass of formula Cu_2Zn and a eutectic corresponding to the formula Zn_2Cu. Upon a mass so constituted a feeble saline electrolyte attacked in

the first instance the constituent rich in zinc, whilst the constituent rich in copper assumed an electronegative position, acting, of course, as the kathode of the couple.

But, when the eutectic had been transformed into spongy copper, the latter assumed the electronegative position and the true brass became the anode, hence gradually transforming the whole mass from Muntz metal into spongy copper. In the case of the *Prodano*, the electrolyte was proved beyond all doubt to have consisted of fatty acids due to the use of improper lubricants. Little by little the brazed seam was cuprified until the junction became so weakened that at a pressure of only 130 lb. per square inch the port main steam-pipe opened for a space of 6 feet and consigned four men to an agonising death.

This research, made at the Sheffield College under instructions from the committee of Lloyd's Register, resulted practically in the abolition of brazed copper main steam-pipes, and in the substitution of rolled steel ones.

Reaching the third section of the lecture, this undoubtedly must be regarded in the steel age as the most important, since it dealt with steel. Taking the base of steel, namely, pure iron, this had a similar structure to that of pure gold, but the etching figures exhibiting the molecular orientation in the allotrimorphic crystals of this metal were seldom revealed by ordinary etching.

Broadly speaking, iron was converted into steel by the addition of the element carbon, and researches made in the Sheffield College indicated that steels naturally divided themselves into three classes, namely, unsaturated, saturated, and supersaturated steels. If 0·3 per cent. of carbon were added to steel, the carbon converted one-third of the iron into the constituent pearlite, and in such a steel, as cast, the iron or ferrite frequently arranged itself into a pattern, indicative of cubic crystallisation exactly comparable with the figures observed by Widmanstätten in the non-terrestrial steels called meteorites. In saturated steels, just sufficient carbon, approximately 0·9 per cent., had been added to the ferrite to convert it totally into the constituent pearlite, a definite mixture corresponding to the formula ($21Fe+Fe_3C$). This definite mixture presented at least three well-marked phases having different mechanical properties determined by the state of the division of the carbide Fe_3C. These phases might be differentiated by distinguishing the involved carbide as emulsified, normal, and laminated, the latter being the pearly constituent of Sorby, presenting a play of gorgeous colours, determined by the varying thickness of the laminæ acting like mother-of-pearl in nature, or the interference grating in science. Through no scientific foresight, but, as a matter of fact, by an act of carelessness, there had been secured at the Sheffield College a section showing the transformation of pearlite into hardenite in the most perfect manner yet recorded. The two constituents, pearlite and hardenite, might humanly be described as the most important in nature, since upon unhardened and hardened steel depended the remarkable triumphs of the civil, the mechanical, and the electrical engineer.

The quartz-hard transformation product of pearlite discovered by the versatile genius of Dr. Sorby itself presented what might be termed effective and futile phases, dependent upon the temperature of quenching. In properly quenched steel, the accidental section before referred to showed that at a moderate temperature the transformation proceeded, not suddenly, but from a series of converging centres, until the whole mass consisted of the obsidian-like substance, structureless hardenite. At too high a temperature this steely obsidian developed decisive cubic crystallisation, recorded in the micro-structure by equilateral etching figures indicative of ruined steel. In supersaturated steel in the unhardened condition, the cells of pearlite were environed by brilliant walls of cementite, Fe_3C, which in hardened steel enveloped similar cells of hardenite, corresponding to the empirical formula $Fe_{21}C$.

Of the three broad types of steel described, by far the most important was unsaturated steel, a synonymous term for which was structural steel, embracing boiler-plates, ship-plates, bridge-plates, rails, and the gigantic engine parts which formed the backbone of our battleships and cruisers.

To show the enormous importance of the scientific study of this class of steel, it was well to indicate, not only its failure, but after brilliant service, also that of the microscope scientifically applied.

The figure thrown upon the screen was that of a boiler, which might be described as several sorts of boiler. It was a marine boiler, a cruiser's boiler, and possibly a mad boiler—it was, at any rate, cracked. Fortunately this rupture occurred before the cruiser was put into commission, and a defect in the steel which might have resulted in a catastrophe was detected by an extra inspection after the boiler had been impressed with the Government pass mark. The chronology of the testing operations was recorded in the following table:—

Date	Nature of pressure	lb. per sq. in.
February 5	Hydraulic	228
,, 8	,,	260
,, 19	,,	305
,, 20	Steam	60
,, 21	Hydraulic	270 (burst)

The mechanical tests of the boiler-plate steel which had thus failed left little to be desired, and the same remark applies to static mechanical tests taken along the line of fracture. Micrographic tests indicated that the steel presented marked features of inferiority when compared with undoubtedly good boiler-plate steel. Superficially the matter was thus solved, but, under alternating or dynamic stress tests, slightly beyond the elastic limit, the steel registered tests varying from 230 to 1292 alternations. The most disconcerting feature in these astoundingly divergent tests was that the test bars registering them were identical in micrographic structure.

At the Cambridge meeting of the British Association, the lecturer suggested that these divergent tests must be associated with opposite sides of the plate subjected to varying heat treatment. The lecturer was quite wrong; and, after twenty-five years' experience, had failed to realise the fact that in connection with steel one must often expect the unexpected.

Remarkable failures in structural steel were commonly associated with the phenomenon called "fatigue." What was "fatigue"? Some little time ago, in an important naval trial at the King's Bench, counsel requested the lecturer to define for My Lord the meaning of this term, which had frequently occurred during the trial, and which he failed to understand. Unfortunately the lecturer also was involved in the outer darkness of My Lord on this matter, but was compelled to give "fatigue" at that time a definition, which remains substantially true to-day, namely, that he regarded "fatigue" as a generic term used clearly to explain all cases of fracture which were not understood. Before venturing to suggest an explanation for these mysterious fractures, for which popular blame often fell upon men who were doing their very best, he would ask his hearers to imagine that that small cloud, no bigger than a man's hand, now hovering over the North Sea, should burst in storm, and that our armour, our guns, and our armour-piercing shells should be put to the stern implacable test of actual warfare. Supposing our guns were faulty, our shells failed to penetrate the armour of the enemy, our armour was incapable of protecting the gallant inmates of our battleships; assuming this hypothesis, which the lecturer believed to be totally untrue, what would all this mean? It would mean that the internal architecture of British wrought steel was all wrong, and the interesting question thus arose, who were the men responsible for the internal architecture of these metals? The lecturer knew them well. They were grave-eyed men with set mouths, who, week after week, month after month, and year after year, lived and moved, and had their being, and sometimes died, amid the flare of gigantic furnaces and the rattle of Titanic rolls, steadfastly working upon those metals which formed Britain's first line of defence, and to-night, on behalf of these inarticulate men, the lecturer confidently asked his distinguished audience to exclaim in their hearts, "These men have deserved well of their country."

Reverting to the remarkable and disconcerting fact that two pieces of the faulty boiler-plate steel of identical structure, so far as could be seen by the microscope, gave astoundingly different results under dynamic stresses, the

lecturer put forward as a tentative hypothesis the theory that, underlying the gross and visible micro-structure of the steel, there existed a molecular structure, which in the present state of knowledge could not be detected, except in rare cases, by the microscope. It was suggested that this molecular structure was brought about by improper heat treatment developing in the ferrite from a series of centres well developed mineral cleavage. On the circumference of these centres existed areas in which the molecular cleavage was less perfectly developed, and beyond these were the areas of good steel. in which the cleavage lines were extremely imperfect. It was then easy to conceive that the plane of dynamic fracture in a perfectly developed cleavage area might give the remarkably low record of having endured only 230 alternations, as in the table previously exhibited on the screen, whilst a test-piece in which the plane of fracture went through an area of good steel free from what might be called cleavage disease might readily endure 1290 alternations before breaking, and a third test-piece from the middle zone of somewhat developed cleavage might endure, say, 700 alternations. This theory, at any rate, was in accordance with the mechanical facts which had been presented. Another step towards the experimental verification of this hypothesis would be to prove that iron was a veritable mineral, as capable of exhibiting geometrical cleavage as was, say, fluor-spar or Carrara marble. Fortunately the lecturer

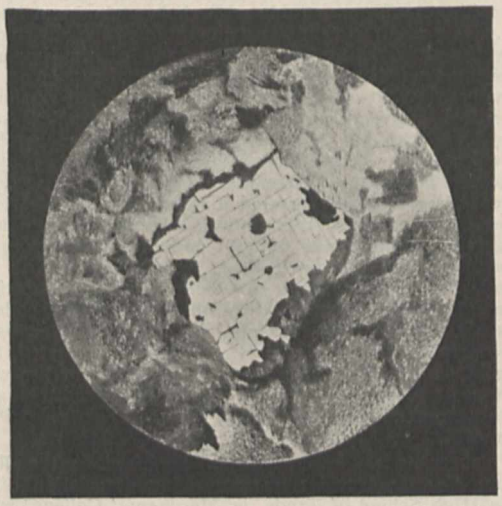

FIG. 3.

found himself in a position, by what might be called a million-to-one chance, clearly to prove that iron could possess absolutely perfect mineral cleavage parallel to the faces of the cube. This discovery came in no heroic form from the swift-moving machinery of a destroyer or in connection with metal forming the stupendous engines of a battleship, but in connection with a wrought-iron bolt, literally forming part of a common or garden gate-post. This fractured under the taps of a hand-hammer during repairs, and one of the crystals cleaved exactly at right angles to the axis of the bolt, and consequently when the fractured end was cut off in the lathe for examination, it was found at right angles to the axis of the microscope, exhibiting the wonderfully perfect cubic cleavage delineated in Fig. 3.

Metallurgists had now arrived at a deadlock. The microscope, after rendering great services, had in its turn broken down, mainly owing to the fact that optical examinations associated with transmitted light could not be applied to opaque objects, and in more senses than one the scientific metallurgist could not yet see through steel. Nevertheless, he must endeavour to tear down this mysterious veil or in some way get behind it, and in the lecturer's opinion the resources of science in connection with steel metallurgy were not yet exhausted.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

MR. A. C. SEWARD, F.R.S., has been appointed professor of botany in the University of Cambridge in succession to the late Prof. Marshall Ward.

WE learn from *Science* that Mr. J. A. Creighton, one of the founders of Creighton University, Omaha, Nebr., has presented to that institution two buildings worth about 100,000*l*.

AN interesting educational development in Manchester is recorded in the *Electrician*. The Corporation of that city has just decided to take approved students from the School of Technology into the electricity works for a three years' training, giving them a certain small but increasing salary during that time. This privilege is to be restricted to sons of Manchester ratepayers.

IT is announced in *Science* that Mr. A. C. Chapin has given Williams College an additional gift of 10,000*l*., to be used by the trustees without restriction, and that Mr. C. T. Barney has given 2000*l*. to the college. It is stated that the fund for Oberlin College, as completed, amounts to 100,300*l*. This includes the following funds:—25,000*l*. for a new library building given by Mr. Andrew Carnegie, 20,000*l*. for library endowment, 20,000*l*. from an anonymous donor in Boston for the increase of salaries of teachers in the college and seminary, and 30,000*l*. for miscellaneous purposes. The gift of the Boston donor enables the trustees to increase by 40*l*. the salaries of twenty-four full professors.

THE following announcement appears in the volume of Regulations (Cd. 3201) just issued by the Board of Education containing the prospectus of the Royal College of Science, London, with which is incorporated the Royal School of Mines (session 1906–7):—"It is probable that as a result of the investigation made by the departmental committee lately appointed by the President of the Board of Education, various changes will be made in the organisation and relations of the Royal College of Science, including the Royal School of Mines. The Board therefore give notice that the arrangements detailed in this prospectus are subject to such alterations as they may determine in respect of the classes for the college session, 1906–7, and of courses of study in future."

THE last report of the Scotch Education Department dealing with secondary education in Scotland directs attention to a new departure in the method of awarding leaving and intermediate certificates. The report states that last year the aid of the teacher was actively enlisted in determining the question of success or failure, and that much weight was attached to a pupil's school record, as properly attested by his teacher, in the allocation of school bursaries. The secretary puts it on record that events have completely justified the confidence of the Department. The teachers, as a body, have risen to the responsibility that was placed upon them. Of course there were cases of miscalculation by the teacher, but these were rare exceptions. The success which this Scottish experiment has met in the direction of humanising the methods of appraising knowledge and intellectual training, with the object of selecting the best pupils, should encourage those responsible for examinations south of the Tweed to increase their efforts to abolish the mechanical character of many of the current tests to which young students are subjected.

THE annual general meeting of the Association of Teachers in Technical Institutes was held on Saturday, October 27. Mr. W. J. Lineham, president, occupied the chair, and Mr. V. Mundella was elected president for the ensuing year. The following resolutions were adopted:—(1) That the association urges the desirability of attendance at evening continuation schools between the ages of fourteen and sixteen being made compulsory upon all not in attendance at elementary or secondary schools. (2) That in view of the generally inadequate provision made in the present scholarship schemes of local educational authorities for the needs of scientific, technological, and trade students, the local branches of the association be instructed to consider what amendments of local scholarship schemes

are necessary to meet the needs of such students, and to press such amendments upon the local education authority with the view of remedying the defects indicated. (3) That the attention of the technological branch of the Board of Education be directed to the desirability of recruiting the staff of inspectors from those with experience in technological teaching.

By the will of the late Mr. John Daglish, Armstrong College, University of Durham, will eventually receive about 45,000*l*. After the payment of claims on the estate and certain legacies, the whole of the testator's property is placed in the hands of trustees upon trust to pay the income to the testator's widow during her life. Subsequently 5000*l*. is to be paid to Armstrong College for the foundation and maintenance of a travelling fellowship in mining and the associated subjects to be called the "Daglish Fellowship." As certain annuities successively fall in, the income is to be paid to Armstrong College for its general purposes, among which three, in the order named, are to have precedence. The first of these is the augmentation of the principal's stipend to 1500*l*. a year, the second is the augmentation of the stipend of the professor of mining to 800*l*. a year, and the third the augmentation of the stipend of the professor of agriculture to a similar sum. When all the annuities have fallen in, the trustees are to hand over 30,000*l*. to the college to be invested for its general purposes. The income of the residue is to be paid to Armstrong College, to be applied as ordinary revenue, until the council of the college shall erect, as one scheme, further buildings costing not less than 20,000*l*., and shall have received from legacies or subscriptions 10,000*l*. applicable to such buildings.

The new buildings of the King Edward VII. Grammar School, at King's Lynn, presented by Mr. (now Sir) W. J. Lancaster, were opened by the King and Queen on Monday. The Town Council of Lynn provided the site for the buildings, which with the foundations cost more than 43,000*l*., and include chemical and physical laboratories and lecture-rooms. In the reply of the King to an address of welcome presented by the Mayor of Lynn, the words occur:—"The occasion of our presence here to-day shows that you are not content with the traditions of the past, however worthy of remembrance those may be; but through the liberality of an old pupil of the school which bears my name, the new buildings of which I am now about to open, are determined to keep abreast of the times, and are conscious that it is only by a thorough education that the younger generation can hope to prove successful in later life." An address was also presented by the governors of the school; and the King read a reply, in the course of which he said:—"You are aware of the deep interest which I have always taken in the public institutions of the county of Norfolk and in all schools established for the purpose of imparting higher education. It is not easy to overestimate the far-reaching benefits of the tuition obtained in such an institution as this. . . . You, as governors of the school, will, I feel sure, exercise the most solicitous care in the direction of the studies of your pupils, that they may be able to face the stress of life with an intellectual equipment such as will enable them to hold their own in the world and bear their part in its work and duties with efficiency and to the benefit of others; nor will, I feel confident, the higher teaching of morality, truth, and self-respect be neglected."

The annual report of the council of the City and Guilds of London Institute for 1906 has reached us. In the last report the council directed attention to the financial position in which the institute had been placed by the reduction of the contributions of the Corporation and the Mercers' and Fishmongers' Companies, but in the present report the council is able to state that the Corporation has reverted to its previous contribution of 500*l*.—the amount in 1904 having been reduced to 400*l*.—and has decided to contribute a similar sum for each of the following five years. The Mercers' Company has also reverted to its original contribution of 2000*l*. The Vintners' Company has increased its contribution, and the Saddlers' Company has withdrawn conditions previously attached to its subsidy. The Fishmongers' Company has yet to rescind its resolution to reduce its contribution from 4000*l*. to 2000*l*. The extracts printed in the volume from the examiner's reports should be carefully read by teachers and students. Apart from the value of the suggestions and criticisms they contain, they afford an instructive insight into the mental capacity of the artisans, who are training to become skilled operatives in many of the chief branches of industry. They show very clearly where the preliminary education of these students is at fault, and the errors into which they most frequently fall. The council remarks that from the reports furnished by the examiners it appears that, on the whole, there is a gradual but distinct improvement in the character of the students' work, and in the knowledge, intelligence, and skill which their answers and exercises display.

An address by Prof. George H. Mead, delivered before the Chicago Chapter Sigma Chi in March last, is reprinted in *Science* for September 28. Prof. Mead states that science in the colleges of Chicago and other American universities has not the importance and popularity that it should have. This is due, it is said, to the freedom of choice of studies in the preparatory schools; the scientific courses are not selected by the children at a period when the concrete subject-matter of science properly presented should be immensely more attractive than languages and abstract studies. The science courses in the high school are not, Prof. Mead affirms, popular at the present time, nor is the money spent on them, whether in equipment or teaching staff, comparable with their educational importance. The result is that the majority of American students leave the universities without a grasp of the important achievements in modern thought, and without being able to interpret what they see, hear, and feel, by means of the splendid generalisations now known to the world. Prof. Mead explains the unpopularity of science in schools and colleges by the statement that scientific problems are no longer within the immediate experience of the student, and not always to be expressed in terms of that experience. In addition, he says, the natural sciences are not interconnected in the minds of the students. Discussing the remedy for this misfortune, Prof. Mead thinks it lies with the schools, where children should be introduced to science in an intelligent manner. Until this is done the colleges, he maintains, should arrange introductory courses in science, in which the subject should be presented from the points of view of history and of a survey of the world of science as a whole. In this way, the address contends, the culture value of science would become clear and suitably esteemed.

A recent article by Mr. J. L. Bashford in the *Westminster Gazette* provides an interesting description of the Berlin High School of Trade, or Merchants' College, which was opened in the presence of the Crown Prince a few days ago. The college has been erected by the Corporation of the Merchants of Berlin at a cost of about 166,000*l*., and will be maintained entirely by the same body. The State has in this instance made no grant, nor did the idea of the college originate with the Education Department. This Berlin school is the only institution of the kind in Germany, and is intended for merchants. The aim of the teachers will be to give the students knowledge and a theoretical training. Lectures will be delivered on all subjects connected with the usances of trade—exchange, banking, Stock Exchange, gold and silver standard, investment of capital; the history and technique of certain branches of industry—*e.g.* electricity, machines and the textile industry, book-keeping, arithmetic and insurance, trade politics, political economy, statistics, social questions, the requirements of workmen in factories, the money market and its organisation in Germany, England, France, and the United States of America; civil law, commercial law, and every other form of law connected with trade relations; commercial geography and commercial history. Philosophical and art studies also find a place in the programme, and knowledge of foreign languages as well as knowledge of foreign countries. The new college contains an aula, capable of holding about 600 persons, and nine lecture-rooms, some for forty and others for fifty, 100, and 150 students, as well as a laboratory for chemistry and one for physics.

FROM Continental contemporaries we note the following recent appointments:—Prof. H. Rubens, professor of physics at the Technical High School, Berlin, to be professor of physics at the University of Berlin and director of the Physical Institute; Prof. Arthur Wehnelt, professor of theoretical and applied physics of the University of Erlangen, to be a professor and departmental director in the University of Berlin; Dr. Joseph Grünwald, privatdocent at the University and the Technical High School of Vienna, to be extraordinary professor of mathematics in the University of Prague; Dr. H. Mache, privatdocent of the Vienna University, to be extraordinary professor of physics in the University of Innsbruck; Prof. Cæsar Pomeranz, extraordinary professor of chemistry in the Vienna University, to be professor of chemistry in the University of Czernowitz; Prof. Karl Zsigmondy, professor of mathematics in the Technical High School, Prague, to the chair of mathematics in the Technical High School, Vienna; Prof. Reissner, privatdocent in the Technical High School, Berlin, to be professor of mechanics in the Technical High School, Aachen; Prof. Zdenko Skraup, professor of chemistry in the University of Graz, to the chair of chemistry in the University of Vienna; Prof. Franz Streintz, privatdocent of the University of Graz, to be professor of physics of the Technical High School in Graz.

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, May 31.—"The Viscosity of the Blood." By Dr. A. du Pré **Denning** and John H. **Watson.** Communicated by Prof. F. Gotch, F.R.S.

It is urged that the full import of a knowledge of the variations in the viscous resistance to be overcome by the blood in circulating through the capillaries and smaller vessels of the system, and the significance of such data to the more exact consideration of a large number of normal and pathological conditions, especially those of the circulatory system, have not been fully realised by either clinicians or physiologists. Experiments have been undertaken to observe the influence of the number of the corpuscles present upon the viscosity of the blood under varying conditions of pressure and temperature, the rate of flow through capillaries of different sizes under the same conditions, and the alterations caused by the additions of certain salts and other substances; one important result of the experiments was to show that the decrease in viscosity for each degree rise of temperature for a blood rich in corpuscles is considerably greater than for a blood poor in corpuscles, especially when the flow is through the finer capillaries, or, in other words, the flow of blood does not follow the fourth power of the radius as required by the Poiseuille formula. An attempt is made to indicate briefly the import of the results obtained in a consideration of the mechanism of the circulatory system. At the end of the paper an account is given of a clinical viscosimeter which the authors have devised for determinations of blood viscosities with but a few drops of blood; such viscosity determinations, it is claimed, are necessary supplements to hæmacytometer observations.

June 21.—"On the Behaviour of Certain Substances at their Critical Temperatures." By Dr. Morris W. **Travers**, F.R.S., and Francis L. **Usher.**

Traube, de Heen, and others have recently suggested that the simple theories of Andrews and Van der Waals may be insufficient to account for the changes which take place in pure substances at their critical temperatures. Their evidence appears to show that in the case of such substances as ethyl alcohol and ether the Cagniard-Latour temperature is dependent on the relative volumes of the two phases, and to account for this they have suggested the existence in the system of complex molecules.

The authors have carried out investigations with ether and with sulphur dioxide, and have found that the Cagniard-Latour temperature is independent of the conditions under which the experiments are carried out. Particular precautions were taken to obtain the liquids pure and to maintain steady temperatures, the measurements of which were certainly accurate to within 0°·05.

The second part of the paper deals with the phenomenon of opalescence which is observed in pure liquids at their critical temperatures. If varying quantities of a pure liquid are heated in sealed glass tubes, provided that the liquid neither disappears nor completely fills the tube before the critical temperature is reached, the surface separating the two phases may sink and disappear near the bottom of the tube, or it may remain stationary about the middle of the tube, or, lastly, it may rise and vanish near the top. In all three cases, if the temperature is raised so slowly that equilibrium is attained without ebullition of the liquid phase, the contents of the tube become opalescent at a temperature slightly below that at which the surface vanishes, the effect being similar to that produced by the action of oxidising agents on a solution of sulphuretted hydrogen. When the surface is falling the opalescence appears in the space below it, and when the surface is rising, in the space above it. In either case the opalescence is confined to the space in which it first appeared by the moving surface, and its intensity is inversely proportional to the volume it occupies. Although it is fairly evenly distributed through the space it occupies, it is usually more intense very near to the surface, and when the latter disappears gradually becomes diffused through the whole tube.

In the case where the surface appears to remain stationary, the tube appears slightly and evenly opalescent throughout its whole length, and if, when this is the case, the volume of the space containing the substance is increased or decreased, opalescence appears below or above the surface itself, and its intensity is inversely proportional to the space it occupies. The effect persists over a finite range of temperature. In the case of sulphur dioxide it sets in at 0°·1 below that at which the surface vanishes, attains a maximum at about 0°·05 above it, and completely disappears at a temperature 0°·1 higher. In the case of ether the effect persists over about 2°.

The conditions necessary for the existence of complexes in a liquid-vapour one-component system in the neighbourhood of the critical temperature were given by Donnan at the British Association in 1904. He suggested that at the critical temperature the interfacial tension becomes zero for ordinary values of the radius of curvature, but remains positive for very small values, for which it does not become zero until the critical temperature is passed. Hence it may be assumed that at temperatures slightly below the critical the interfacial tension is greater for very small radii of curvature than for ordinary curvatures. If over a range of temperature, including the critical temperature, limited above by the temperature at which the interfacial tension for very small curvatures becomes zero, and below less sharply, small non-molecular aggregates can be formed, it follows that these will be differentiated from either the liquid or vapour phase, and will have a stable existence. To such aggregates is attributed the phenomenon of opalescence, and the range of temperature over which it is observed, and the manner of its appearance and disappearance, are in agreement with the assumptions.

PARIS.

Academy of Sciences, October 29.—M. H. Poincaré in the chair.—A new and rapid method for the determination of the errors of division of a meridian circle: M. **Lœwy.** A more detailed discussion of a method described in outline in an earlier paper.—The moth of the beetroot, *Lita ocellatella*: Alfred **Giard.** The author has recognised by a further study of this parasite that he was in error in identifying it as belonging to the species *Loxostege sticticalis* of American naturalists, or *Phlyctoenodes* or *Eurycreon sticticalis*, according to the European nomenclature. The author points out the remarkable facility with which the larvæ escape through small apertures, and the danger through this cause of sending live specimens through a district not subject to this pest.—Observations on the sun made at the Observatory of Lyons during the third quarter of 1906: J. **Guillaume.** The results are summarised in three tables, giving the surfaces of the sun-spots, their distribution in latitude, and the distribution of the faculæ in latitude.—The deformation of quadrics: Luigi **Bianchi.**—The transformations of some linear partial differential equations of the second order:

J. **Clairin.**—The system of integrals of total differentials belonging to a hyperelliptic surface: E. **Traynard.**—The complementary geodesic triangulations of the higher regions of the French Alps: P. **Helbronner.**—The velocities of detonation of explosives: M. **Dautriche.** The author describes a new method of measuring these velocities by the use of an explosive string. The two ends of this are fired simultaneously by a detonator, and the point at which the two detonations meet determined by a special device. After the accuracy of the method had been determined by blank experiments, in which both arms of the circuit consisted of the same material, a tube containing another explosive was inserted in one of the arms. It was found possible to measure the retardation to one hundred-thousandth of a second.—Stereoscopic relief by projection: E. **Estanave.**—The dissociation of matter under the influence of light and heat: Gustave **Le Bon.** Remarks on a recent paper by Sir W. Ramsay and J. Spencer.—The migration of the phenyl group: mode of fixation of hypoiodous acid and of the elimination of hydriodic acid: M. **Tiffeneau.** In the fixation of HIO the hydroxyl group attaches itself by preference to the carbon atom to which the greatest number of groups are fixed, and to that nearest the phenyl group. In the elimination of HI the hydroxyl group nearest the phenyl group remains unattacked, and there is a migration of the phenyl. If, on the contrary, the hydroxyl group is removed from the phenyl group, the elimination of HI tends to form ethylene oxides.—Some new observations made at the summit of Mt. Blanc on the effect of high altitudes on the blood corpuscles: H. **Guillemard** and R. **Moog.**—The coagulability of the subhepatic blood: MM. **Doyon,** Cl. **Gautier,** and N. **Kareff.** Contrary to the usually accepted views, the authors, from experiments on more than fifty dogs, conclude that the subhepatic blood does coagulate, and also contains fibrin.—The lakes of the ring of Rabuons, Maritime Alps: André **Delebecque.** An account of hydrographic researches done on these lakes during the summer of 1906.

DIARY OF SOCIETIES.

THURSDAY, NOVEMBER 8.

ROYAL SOCIETY, at 4.30.—The Occurrence of Encystation in *Trypanosoma grayi* (Novy); with Remarks on Methods of Infection in Trypanosomes generally: Prof. E. A. Minchin.—Note on the Continuous Rays observed in the Spark Spectra of Metalloids and some Metals: Prof. W. N. Hartley, F.R.S.—The Composition of Thorianite, and the Relative Radio-activity of its Constituents: Dr. E. H. Büchner.—A Numerical Examination of the Optical Properties of Thin Metallic Plates: Prof. R. C Maclaurin.—On a Compensated Micro-manometer: B. J. P. Roberts.—Experimental Investigation as to the Dependence of Gravity on Temperature: L. Southerns

MATHEMATICAL SOCIETY, at 5.30.—Annual General Meeting.—Presidential Address: Partial Differential Equations; some Criticisms and some Suggestions: Prof. A. R. Forsyth.—Harmonic Expansions of Functions of Two Variables: Prof. A. C. Dixon.—The General Solution of Laplace's Equation in n Dimensions: G. N. Watson.—On Sub-groups of a Finite Abelian Group: H. Hilton.—On Bäcklund's Transformation and the Partial Differential Equation $s=F(x, y, z)$.—On the Inversion of a Definite Integral: H. Bateman.

INSTITUTION OF ELECTRICAL ENGINEERS, at 8.—Presentation of Premiums awarded for Papers Read or Published during 1905-06.—Inaugural Address by the President, Dr. R. T. Glazebrook, F.R.S.

FRIDAY, NOVEMBER 9.

ROYAL ASTRONOMICAL SOCIETY, at 5.—On the Effects of Radiation on the Motion of Comets (Second Note): H. C. Plummer.—(1) On the Early Eclipses; (2) The Early Eclipses of the Sun and Moon: E. Nevill.—Note on a Mechanical Solution of Kepler's Equation: H. C. Plummer.—On the Possibility of Improving the Places of the Reference Stars for the Astrographic Catalogue from the Photographic Measures: H. H. Turner.—The Systematic Motions of the Stars: A. S. Eddington.—Stellar Parallax Papers, No. 3, The Parallax of Eight Stars, from Photographs taken at the Cambridge Observatory: H. N. Russell.—Auroræ observed at Delting, Shetland, 1905-6: Rev. A. C. Henderson.—*Probable Papers:* Solar Parallax Papers, No. 5, Examination of the Photographic Places of Stars published in the Paris *Eros* Circular: A. R. Hinks.—Notes on Theoretical Spectroscopy: E. T. Whittaker.

PHYSICAL SOCIETY, at 8.—Exhibition and Description of Experiments Suitable for Students in a Physics Laboratory: G. F. C. Searle.

MALACOLOGICAL SOCIETY, at 8.—Description of a New Species of Calliostoma from S. Formosa: E. A. Smith, I.S.O.—Description of a New Sub-genus and Species of Alycæus from Ke-lan-tan: H. B. Preston.—Description of Six New Species of Shells and of *Leptomya lintea*, Hutton, from New Zealand: H. Suter.—Descriptions of some Tertiary Shells from New Zealand: H. Suter.

MONDAY, NOVEMBER 12.

ROYAL GEOGRAPHICAL SOCIETY, at 8.30.—North-Eastern Rhodesia: L. A. Wallace.

TUESDAY, NOVEMBER 13.

INSTITUTION OF CIVIL ENGINEERS, at 8.—Single-phase Electric Traction: C. F. Jenkin

ZOOLOGICAL SOCIETY, at 8.30.—On the Embryo of the Okapi: Prof. R. Burckhardt.—Zoological Results of the Third Tanganyika Expedition, conducted by Dr. W. A. Cunnington, 1904-05. Report on the Turbellaria: F. F. Laidlaw.—List of Further Collections of Mammals from Western Australia, including a Series from Bernier Island, obtained for Mr. W. E. Balston; with Field-notes by the Collector, Mr. G. C. Shortridge: Oldfield Thomas, F.R.S.—The Mollusca of the Persian Gulf, Gulf of Oman, and Arabian Sea, as evidenced mainly through the Collections of Mr. F. W. Townsend, 1893-1905; with Descriptions of New Species, Part ii., Pelecypoda: J. Cosmo Melvill and Robert Standen.

MINERALOGICAL SOCIETY, at 8.—Growth of Crystals of Soluble Salts on Each Other: T. V. Barker.—Notes on Some Bolivian Minerals: L. J. Spencer.—Note on Ilmenite from Brazil: G. F. Herbert Smith.—Description of the Lengenbach Quarry and of the Minerals found there in 1906: R. H. Solly.—Note on the Thirty-two Classes of Symmetry: H. Hilton.—Note on a Canadian Mineral: Prof. Harrington.

FARADAY SOCIETY, at 8.—Some Investigations Relative to the Depreciation of Electrolytically-produced Solutions of Sodium Hypochlorite: W. Pollard Digby.—The Hermite Electrolytic Process at Poplar: C. V. Biggs.—On the Electrochemistry of Lead: Dr. A. C. C. Cumming.

THURSDAY, NOVEMBER 15.

ROYAL SOCIETY, at 4.30.—*Probable Papers:* Calcium as an Absorbent of Gases, and its Applications in the Production of High Vacua and for Spectroscopic Research: F. Soddy.—A Method of Gauging by Evaporation the Degree of High Vacua: A. J. Berry.—The Effect of Temperature on the Activity of Radium and its Transformation Products: Dr. H. L. Bronson.—On the Refractive Indices of Gaseous Potassium, Zinc, Cadmium, Mercury, Arsenic, Selenium and Tellurium: C. Cuthbertson and E. P. Metcalfe.—The Photo-electric Fatigue of Zinc: H. S. Allen.

CHEMICAL SOCIETY, at 8.30.—On the Determination of the Rate of Chemical Change by Measurement of Gases Evolved: F. E. E. Lamplough.—Xanthoxalanil and its Analogues: S. Ruhemann.

LINNEAN SOCIETY, at 8.—Recent Researches in Norway: Horace W Monckton.

FRIDAY, NOVEMBER 16.

INSTITUTION OF MECHANICAL ENGINEERS, at 8.—Steam as a Motive Power for Public Service Vehicles: T. Clarkson.

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