THURSDAY, MARCH 20, 1902.

REFORM OF THE TEACHING OF MATHEMATICS.

British Association Meeting at Glasgow, 1901. *Discussion on the Teaching of Mathematics, which took place on September* 14 *at a Joint Meeting of two Sections, Section A, Mathematics and Physics, Section L, Education.* Edited by John Perry. Pp. vi + 101. (London : Macmillan and Co., Ltd.) Price 2*s.* net.

PROF. PERRY'S views concerning the teaching of mathematics have been expounded often in the columns of NATURE and elsewhere, and have aroused a great deal of interest. It was a happy idea to bring about a discussion of these views at a joint meeting of the mathematical and educational Sections of the British Association. The report of that discussion has been issued as a separate small volume. It contains the introductory address delivered by Prof. Perry, a specimen syllabus prepared by him for use in training colleges, the discussion that followed the address, written remarks on the subject communicated by several teachers who did not take part in the discussion, and Prof. Perry's reply. The discussion was restricted to what may be called a possible school range of mathematics ; the teaching of advanced mathematics at the Universities was scarcely touched upon. As an outcome of the discussion, a committee of the British Association was appointed

"to report upon improvements that might be effected in the teaching of mathematics, in the first instance of elementary mathematics, and upon such means as they think likely to effect such improvements."

The movement thus initiated is important. Many of the more enlightened teachers of mathematics in Britain have long been dissatisfied with the conditions under which they have been compelled to work ; and efforts in the direction of reform have been made, in particular by the Association for the Improvement of Geometrical Teaching. The smallness of the results achieved by those efforts is to be traced mainly to the action of the chief examining bodies ; but there are not wanting signs that these bodies are now less complacently conservative than they have been in the past. It is earnestly to be hoped that the indicated change of attitude may turn out to be real. The handy publication under notice should be of great assistance to those who are agitating for reform.

The movement is in great part a reaction against the pedantic and unpractical character of the habitual teaching of mathematics in schools. This character belongs both to the methods of presenting particular subjects and to the order in which the subjects, and the parts of the subjects, are studied. The methods and the order now in vogue are not, of course, a system devised purposely ; they have been arrived at gradually, and are sanctioned by tradition. The principles of the proposed reform may be stated broadly as follows :—(1) The way for every abstract generalization should be prepared by intelligent practice of comparatively concrete processes, chosen so as to stimulate inquiry ; (2) whenever a choice of alternative orders is offered, that order should be preferred which conduces best to the application of mathematics to practical needs. A subsidiary principle of reform would be that all purely artificial and unimportant developments should be omitted. The principles thus stated will not perhaps excite much opposition ; yet far-reaching and radical changes would be required to give effect to them. One result that may be expected to follow from such changes would be that the study of the elements of mathematics would become a better preparation than it is at present for the study of the more advanced theories. The mathematics of most of our elementary text-books is felt to be almost as much out of touch with modern mathematics as with everyday life. This conviction has had some share in promoting the movement in favour of change.

As regards geometry, the thoroughgoing adoption of the above-stated principles of reform would lead in the first place to the introduction of courses of practical work in drawing and measuring, which would precede and accompany the study of demonstrative geometry ; and it would lead in the second place to a great simplification of that study. That simplification would consist partly in the abandonment of Euclid's "Elements" as a text-book. The difficulty of finding a generally acceptable substitute for Euclid was fatal to the proposals of the Association for the Improvement of Geometrical Teaching, and the controversy between the supporters and the opponents of Euclid has been a main feature of all discussions concerning the improvement of the teaching of mathematics in this country. Now it may be contended that we ought not to attempt to present geometry to children as a formal system deduced from a minimum number of assumptions ; but that our objects should be to impart knowledge of the properties of geometrical figures and to cultivate power of geometrical reasoning. Upon the general adoption of this view of the true objects of geometrical teaching, the above-mentioned difficulty would disappear ; for it is safe to assert that these objects can be secured better without Euclid's book than with it. In this matter the French are far ahead of us. Their text-books of geometry have been evolved by a natural process of development from the "Géométrie" of Legendre ; and text-books similar to those of France are in use in Germany, Italy and the United States. It is far from my purpose to suggest that British teachers should now adopt as a substitute for Euclid a translation of a French book or any other foreign book. In all these books too much attention, as I think, is paid to the development of a formal logical system, with the result that much space is occupied in proving propositions that are sufficiently obvious without proof. We have yet to work out for ourselves the method that is best suited to our educational needs and national temperament. This cannot be done without freedom from the tyranny of an orthodox standard ; nor can it be done in a hurry. Changes will have to be made gradually. In this connexion we may note that the memorial sent by some schoolmasters to the committee of the British Association (NATURE, January 16, 1902, p. 233) points out a promising method of beginning to make changes. If the chief examining bodies would now sanction such a departure from existing practice as is there proposed, progressive reform would become possible.

The contention that Euclid's "Elements" is an unsuitable text-book is borne out by a critical scrutiny. The book was an attempt to deduce a complete system of geometry from a minimum number of assumptions, contained in definitions, axioms and postulates. No such attempt, even if completely successful, can possibly appeal to immature minds; and it is well known that Euclid's attempt, in spite of its many conspicuous merits, is logically defective. This would not matter very much if it were otherwise well adapted to effect the two objects which we have noted above as the true objects to be aimed at in teaching geometry. Notoriously it is not so adapted; striking instances of its deadening effect upon the minds of average boys have been recorded by Prof. Minchin and others. Such instances may fairly be cited in opposition to the claim, urged by the supporters of Euclid, that his system affords valuable mental training; and this claim does not gain in force when it is observed that most of the men who have undergone the training appear to be unable to appreciate the logical defects of the system, and that they accept without question the absurdities that are often made to do duty, in our text-books of analysis and mechanics, as definitions or as proofs. Further, the tacit agreement to drop Euclid's fifth book has robbed his sequence of its significance. This book is really the great contribution of antiquity to the problem of irrational numbers—perhaps the central problem of mathematics. It is certainly the keystone of Euclid's system. Without it, there is no reason why proportion and measurement, treated arithmetically, should not take a much earlier place in a system of geometry. In elementary stages, it will probably be best to postpone all questions of incommensurable magnitudes and irrational numbers; but sooner or later, in the training of a mathematician, such questions must be faced. The Greeks approached arithmetic through geometry, and for two thousand years Euclid's fifth book was the only theory of irrational nnmbers. Now, however, the Greek way is not the only way, nor, as I believe, the most excellent. There exists now a complete arithmetical theory of irrational numbers; and the theory of exact measurement of incommensurable, as well as of commensurable, magnitudes can be founded on a secure arithmetical basis. This revolution of mathematical thought was accomplished in Germany in the second half of the nineteenth century; its full effect has yet to be felt.

But geometry is not the only branch, even of elementary mathematics, of which the aspect would be changed entirely by giving effect to the above-stated principles of reform; nor is the need for improvement confined to the teaching of elementary mathematics. In algebra, for example, the changes advocated in the book under notice, or those proposed in the memorial of some schoolmasters already referred to, would constitute great improvements in the method of presenting the subject. Here again the French text-books are much better than most of ours. In analysis generally, the traditional order of the topics stands in need of drastic alteration—boys and girls ought not to be taught to expand the circular functions in infinite products before they have ever plotted a graph or differentiated the simplest expression. Prof. Perry has been a constant advocate of graphic methods and of the early study of the differential and integral calculus. He holds that this study should precede that of many things which now come before it, *e.g.* advanced analytical geometry of conics; this view is put forward on the ground that such an order would be more helpful to those students who will afterwards require to use mathematics in the practice of their professions. They are not the only students who would gain by the change. The educational value of mathematics would be increased enormously. Mathematics becomes an instrument of liberal education, not merely by the practice of processes—they are means to an end—nor yet by the storing of information, though knowledge of facts is an element of culture—but by the formation of exact ideas as regards both the definiteness of its fundamental notions and the inevitableness of its results. The impression that is made upon the mind, when one realises the inexorable necessity of the conclusion of a chain of reasoning, is the element in mathematical training that has been emphasized the most by those who support the claim of mathematics to be considered an integral part of a liberal education; but it may be held that the illumination to be derived from any of the fundamental notions of mathematics—such notions, for example, as proportion, continuity, vector, group—when they are thoroughly grasped, is a not less important element from the same point of view. The traditional order of study has tended to obscure the fundamental notions and the general drift of the arguments under a cloud of secondary developments. That the differential and integral calculus can be presented at such a stage as that indicated by Prof Perry, in a manner so practical as to suit the student of engineering, and at the same time so rigorous and so luminous as to be a worthy means of liberal education, has been shown by more than one recent treatise. The examinations that have most influence upon the order of study near this stage are probably those for entrance scholarships at the colleges of the older Universities. A few reforming tutors might now initiate a change that would produce a very great effect.

It is unnecessary here to follow out the application of the principles of reform to mechanics, or to the remaining subjects of a school course of mathematics. The book under notice contains numerous suggestions on these heads. Some readers may be inclined to think that in the introductory address, and in some of the subsequent speeches, undue prominence was given to the needs of students who are destined to become engineers, or teachers in primary schools. A view that is held widely, but has not perhaps been emphasized sufficiently, is that, in the stage of ordinary school work, the course that is most suitable for such classes of students is also precisely the best for those for whom mathematics is meant to be a means of culture and for those who have the ability, and will afterwards have opportunities, to assist in the development of mathematical theories. To bring such a course into general use will require much persistent effort, directed continually to one end; and the first step will necessarily be the conversion of examiners and of the bodies that make regulations for the conduct of examinations. The future of mathematical teaching in this country is in their hands. A. E. H. L.

A STUDY IN FISH MORPHOLOGY.

Pleuronectes. Liverpool Marine Biology Committee's Memoirs on Typical British Marine Plants and Animals. No. viii. By F. J. Cole and Jas. Johnstone, B.Sc. Pp. 252; 11 plates, 5 text figures and a table. (London: Williams and Norgate, 1901.) Price 7*s.*[1]

OF the now numerous publications of the Liverpool Marine Biology Committee which have appeared since its foundation, none are of greater service to zoologists and students than those of the series to which the volume under review belongs. They are each a detailed study of some individual organism, prepared by a writer or writers specially familiar with the group to which it belongs; and under this guarantee of authority, they are consequently welcome and most useful wherever the zoology of the British seas is studied or taught. The first memoir, on the "Ascidian," by Prof. Herdman (to whom honour is due for having inspired and initiated this most admirable series), appeared but in 1899; and in the interval of little more than two years which has elapsed, there have been published seven others—the present volume being the eighth. In bulk and descriptive detail, this is by far the most extensive and elaborate yet issued, since it is nearly three times the size of its heaviest predecessor, and is illustrated by eleven plates as compared with a previous maximum of seven. When, however, it is remembered that it has two authors and deals with a verteb rate, and that it exhausts not only the organology, but treats of the life-history, habits and economic aspects of the fish selected for treatment, it is evident that a just allocation has been given it. Indeed, in its method of treatment it is at once both wider and more special than its predecessors.

Both authors have already so distinguished themselves as trustworthy investigators, at Liverpool and elsewhere, that their cooperation gave promise of a good result, and in the end our highest expectations have been fulfilled.

The introduction to the book opens with a consideration of classification, the value of the Müllerian subordinate term "anacanthini" (now unquestionably doomed) and of the less familiar "heterosomata" being duly explained. In dealing with the external characters, the more recent work on chromatology is adequately incorporated, with due mention of authority; and while the descriptions of the lateral line organs and scales are fully up to date, and the "breathing valves" are duly recognised, slight error is obvious only in the application of the terms descriptive of the condition of the tail to that organ and not the fish itself. The subjects of torsion and asymmetry, as involving the head and dorsal fin and leading up to accurate definitions of the "eyeless" and "ocular" sides, are extremely well handled, both in this introduction and in a subsequent section, following that treating of the eye-muscles, which play so important a part in the processes involved and in furnishing a clue to their real nature. Rival theories are discussed, to the denunciation of those of Cunningham, based upon the study of the sole, certain other of whose observations come in for criticism in many pages of this work.

The osteological chapters come next in order of succession, and they are thoroughly good and sound. The bones of the "eyeless" and "ocular" sides are alternately described; the compound nature of the pterotic and sphenotic elements is fully considered, in its bearings on both morphology and terminology; the absence of the left nasal is explained; and the details in respect to which the inter-maxillary cartilage enables the plaice (in contradistinction to other Pleuronectidæ) to pick up food on its eyeless side, are made admirably clear. The vertebral column and fin-supports are fully considered; and while we doubt the advisability of retaining the term "atlas" for the first vertebra, we welcome the adoption of "axonost-" and "baseost" and the recognition of the work of Traquair, Bridge, and others who are named. We regret, however, that while our authors were thus far revising their terminology they did not, for once and for all, replace the term "anal" in ventral for the post-anal median fin.

Concerning the anal spine, it is noteworthy that the authors have been at immense pains to be perfectly sure that this does not project uncovered during life; and it may be said that no less labour has been bestowed upon the accurate determination of the nature and precise limitations of the pancreas, the lymphatic portion of the head-kidney, the thymus gland, and other organs which text-book writers are too apt to sketchily consider. Their desire to be thorough at all costs is, in fact, one of the distinguishing features of their book; and consequently, we find descriptions of the adult supplemented by comparison with the young, as in their account of the development and retrogression of the thymus, of the thyroid and suprarenal organs, of the hypoblastic origin of the "bladder" (which we rejoice to find termed the *urocyst*) and other allied parts. In all this and a great deal more their memoir is a record of laborious research, done for the love of the work and with the determination to be exact; and no less praiseworthy are their literary efforts, which have led them, when called upon to deal with things of doubtful homology or function, to state fully alternative possibilities, with due reference to authority, as, for example, in their treatment of the "interclavicle" and the "pyloric cæca."

The section dealing with the blood vascular system calls for no especial comment, except that it is accurate and well done, and that a good service has been rendered in a *résumé* of the chief conditions assumed by the pseudobranchial vessels. The authors' extreme caution is again obvious, in their refusal to decide upon the homology of this pseudobranch (in the absence of a related afferent branch of the ventral aorta) until dealing with its in-n rvation. And this leads naturally to the consideration of their section on the nervous system, which, as might be expected from the senior author's work, is their *pièce de résistance*. In the portion of this which deals with the cranial nerves, we are taken at once into a dissertation on the two-root law of Bell and the four-root theory of Gaskell; and, apropos of the far-reaching investigations of Strong and the labours of Herrick on Menidia, to a classification, based on the "component theory" and work done under the conviction that the whole course of these

[1] Like three of its predecessors, which were written wholly or in part by members of the staff of the Lancashire Sea Fisheries Laboratory, the memoir is also incorporated as an Appendix in their Annual Report Rep. x. 1901).

nerves should be determined by means of serial sections. Rather too much this to expect from the ordinary student! especially when it is seen that the classification discriminates between five systems (viz.—somatic-afferent and -efferent, viscero-afferent and -efferent, and acustico-lateral) "each delimited by a uniformity of peripheral termination and a special characteristic origin in the brain," and each liable to "appear in a variable number of cranial nerves as a component of those nerves." Our authors tell us they have adopted this method for the plaice, and in proceeding to the systematic description of its cranial nerves they deal with them in order of functional association. The olfactory, optic and eye-muscle nerves are first considered; then the fifth and seventh; after the study of their root-ganglia, the eighth, ninth and tenth, completing the series. With the spinal nerves, the fourth is described first, and the first three later in order of succession, because they are less typical and by virtue of their especial relationships to the pectoral member. It is impossible here to go more fully into the details of this very technical subject; suffice it to say that all is most admirably set forth, and that while a really good description of the sympathetic system is given which may serve as a model to writers of the future, both the giant cells of the cord and the most recently revived Reissner's fibre are described and discussed with full bibliographic treatment. Special discussion is given to the question of the innervation of the pelvic member, in its bearings on translocation and nervous substitution, as a guide to homology. The authors' arguments under this head have an especial interest, in the recent announcement by Dr. A. Smith Woodward of the startling discovery that, in Cretaceous times, teleostei of the clupeoid type had already translocated the pelvic fin into the jugular position.

Following this are sections dealing with the sense organs. Kyle's discovery of a pleuronectid with a naso-pharyngeal aperture and Holt's "recessus orbitalis" meet with due recognition, and here again all is admirable and fully up to date. The aforementioned thesis on asymmetry is conveniently introduced at this point, and there follow sections on the ear and reproductive organs, with a *résumé* of the present state of our knowledge concerning the sexual organs of the female teleosteans in general, in which Huxley's terminology is employed.

The book closes with an appendix, containing valuable information on spawning and the spawning season, on the maturation and structure of the egg, on oviposition, fertilisation, development and metamorphosis. Rate of growth, the nature and causes of migration and distribution, are duly dealt with, and there follows a brief sketch of the plaice fishery in northern European waters, with some sound advice to the practical fisherman. In not a few pages in the book there are hints as to the work of the future, as, for example, at the very outset, where there are described a sporozoon and a myxosporidian yet to be determined.

Of the eleven plates, all are admirably clear, and figures useful as are those of the cranial nerves, the olfactory sacs and the sympathetic system are most welcome. It is well known that in the production of this series of memoirs the cost of illustration has been largely defrayed by private donation. In the present case the publication committee of the Victoria University have performed this graceful task, and we congratulate its members upon their bargain. A better treatise on a single animal form there hardly exists, and while we would tender to editor, authors and all interested or concerned our heartiest thanks, we cannot refrain from an expression of national pride, in the extent to which it is evident from the pages of this work that the science of comparative ichthyology is essentially English. The book reflects the influence of the schools in which its authors were trained, and is a credit to them and to science in Britain. Our only fear concerning it is that it will be found too voluminous for the mere student, of whom so much is expected in so short a time. There is a danger that at first glance he would be repelled by the great amount of detail, and that thereby the subject of zoology might suffer. Selection can, however, always be arranged under a competent teacher, and for those desirous of specialising in ichthyology we could recommend nothing better. The book is healthy in the extreme, and while it will educate the student on sound lines, it will arouse in him the desire for reinvestigation and research, no opportunity of directing attention to which has been lost.

THE GOLD OF OPHIR.

The Gold of Ophir: Whence Brought and by Whom? By A. H. Keane. Pp. xviii + 244. With one plate and one map. (London: Stanford, 1901.) Price 5*s.* net.

IN the little volume before us Prof. A. H. Keane has undertaken an inquiry into the vexed question of the site of Ophir, and the source of the gold which the Hebrew Scriptures assure us was brought from that place to Solomon, son of David, by ships of Tarshish. The author himself feels that some apology to the reader is necessary, and that some explanation is due to him for having taken up the subject at all, and it is our duty to say at the outset that we wish he had left it for discussion to the class of people who triumphantly assert that Rhodesia is Ophir, and that Britons inherit this colony (which was founded by masterful Mr. Rhodes) as their natural right because they are descendants of some of the tribes of Israel. Prof. Keane thinks that so much evidence has accumulated on the subject during the last thirty years that it is time the question was reopened, and not only reopened, but decided once and for all. The evidence he refers to consists of the results obtained from the exploration and study of Rhodesian remains, from the Himyaritic inscriptions found in central and southern Arabia by Glaser and others, and from the explorations of the "Arabian frankincenseland" by the late Mr. Bent, and from parallels between the social and religious customs of the Malagasy inhabitants of Madagascar and "their Himyaritic, Phœnician and Jewish masters from the northern hemisphere." Incidentally we may mention that Dr. Carl Peters, in 1901, enunciated the extraordinary view that, not only was the site of the Ophir of the Bible to be found in Rhodesia, but that Ophir was to be identified with the Punt of the Egyptian inscriptions.

Prof. Keane has devoted several chapters of his little

book to attempting to prove his theories by appeals to facts philological and geographical; but all that can be said for his arguments is that if every assumption is correct, the deductions which he makes may be true, but if almost any one of them breaks down, his whole fabric must collapse. For example, Prof. Keane says unhesitatingly,

"the original Punt was South Arabia (Arabia Felix, Yemen), whence the name was extended to Somaliland during the eighteenth dynasty, say, about 1700 B.C."

But this is impossible, for in the sixth dynasty Punt was in Africa, and was probably reached by way of the Nile; and as the inscription of Her-khuf, formerly at Aswân and now at Cairo, contains the oldest mention of Punt in such a way that its position can be traced, we see at once that, so far as this remote period is concerned, Prof. Keane has no satisfactory authority for his statement, "the original Punt was South Arabia." The Punt of the eighteenth dynasty was reached in exactly the same way as it was reached in the reign of Seânkhka Râ (eleventh dynasty), and all the Egyptological evidence available goes to show that the region visited by the Egyptians at both periods was in Africa.

Prof. Keane thinks little of the evidence which Dr. Peters has deduced from the "*ushabte* figure impressed in a mould" which he found in the middle of Africa during his last expedition, yet he accepts the description given of it to the effect that it has "in each hand a scourge instead of a hoe." If the figure is an *ushabti* figure, and was really made in ancient days in a region far to the south of Egypt "for a courtier of Thothmes III.," the objects in the hands must have been intended to represent the flail and the hoe of Osiris, otherwise the whole figure is meaningless. In any case, how can it have a curious significance (p. 35) because "it is armed with a scourge in each hand, and [was] picked up in a mining district"? Let us hope that this wonderful figure may be placed somewhere so that it may be inspected by those interested in the matter.

Prof. Keane relies too much upon the statements of the late Mr. Bent in the deductions which he makes about the ruins at Zimbabwe, and this is the case also in respect of the views of the Hon. A. Wilmot, who wrote a volume entitled "Monomotapa," and who adopted nearly all Mr. Bent's views. Mr. Bent was an intrepid traveller and an accomplished gentleman, but he knew no Semitic language and his training as an archæologist was rather classical than anything else; his opinion on all Phœnician matters was, therefore, that of an intelligent but untrained amateur.

Our want of space prevents the possibility of discussing many of Prof. Keane's philological dicta, and we must pass on to his

"important conclusions," which he trusts "may now be considered fairly well established, and may therefore legitimately take the place of the many theories and speculations hitherto current regarding the 'Gold of Ophir,' its source and forwarders" (p. 194).

These are:—Ophir, on the south coast of Arabia, *i.e.* Moscha, or Porters Nobilis, was the distributing market of the gold of Havilah, or Rhodesia. The mines of Rhodesia were first worked by South Arabian Himyarites, who were followed in the time of Solomon by the Jews and Phœnicians, and these very much later by the Moslem Arabs and Christian Portuguese. Tarshish was the outlet for the precious metals, and was near the modern Sofala. The Himyarites and the Phœnicians reached Havilah through Madagascar, where they maintained commercial and social intercourse with the Malagasy natives. With them were associated the Jews, by whom the fleets of Hiram and Solomon were partly manned. There is, of course, something to be said for all these views, because each represents a possibility, but the facts required to prove them are wanting. Nevertheless, Prof. Keane's book is as valuable as it is interesting, because it has put the question on a scientific base, and we are glad to see that he has freed himself from the ordinary traditional trammels in dealing with it. Moreover, we must acquit him of all mercenary motives in trying to prove that the gold which Hiram and Solomon's fleets obtained from Ophir came from Rhodesia, for so far as we know, he has no pecuniary interest in the mining operations which have been carried on in that wonderful country during recent years. The "notes" which he gives will be very useful to other workers in the same field, and his index facilitates the profitable perusal of the present book.

EXPERIMENTAL WORK WITH GASES.

The Experimental Study of Gases. By Morris W. Travers, D.Sc. With preface by Prof. W. Ramsay, D.Sc., F.R.S. Pp. xii + 323. (London: Macmillan and Co., Ltd., 1901.) Price 10*s.* net.

IN 1857, Robert Bunsen published the first edition of his classical work "Gasometrische Methoden," and twenty years later a rewritten and enlarged edition of the same, which still ranks as a standard text-book on the subject. We think it is not too much to say that since that date no more important work has been published on the properties of gases in general than the one now before us. The progress made in our knowledge of the subject has probably been at least as rapid as in any other department of chemistry, and the discovery within the last half-dozen years of five new elementary gases, in the investigation of the properties of which Dr. Travers has taken a prominent part, would alone afford justification for this volume, did it contain nothing else of merit.

The volume consists of 320 pages, with numerous illustrations, most of which appear to be original and not merely reproductions from current text-books. The first portion of the book is taken up with a detailed description of the apparatus used, and the methods employed in the preparation of gases in a state of purity and their accurate measurement and analysis. Then follow chapters on the gases of the helium group, the determination of density and the relations of pressure, temperature and volume, the liquefaction of gases, and finally their properties and the constants relating to them. Careful perusal of the work leads us to the impression that in this case (as is by no means always the rule) the best chapters are those on the subjects with which the

author is peculiarly at home, namely the sections dealing with the gases of the helium group and with liquefaction. On the other hand, the chapter on the preparation of pure gases is somewhat disappointing, not so much on account of what is said as because of what is left unsaid.

In the introductory fifty pages we notice much valuable information, obviously the outcome of experience, regarding the construction of apparatus, such as Toepler and Sprengel pumps, and practical hints on such matters as the cleaning by means of zinc dust and hydrochloric acid of glass apparatus which has become dirty by long-continued use with mercury.

While referring to pumps, we may mention that the statement on p. 15 that a filter pump with a good head of water will reduce the pressure in a vessel to the vapour-pressure of water at the time is well inside the mark. In the writer's experience it is not uncommon to obtain by selection a filter pump which will reduce the pressure to much more nearly one millimetre than 15 to 20 mm., the latter being a degree of vacuum quite easily attainable with almost any good pump and moderate pressure.

For flexible connections to stand high pressures or vacua, the thin weldless steel tubes recommended by Dr. Travers should always be protected by an outer sheath consisting of a compo tube slipped over the steel and drawn tight on to it through several holes of a draw plate. This prevents the steel suffering, as it is very liable to do, from too sudden bends or from accidental crushing.

In attempting to preserve for long periods gases collected in a sample tube over mercury, great caution is needed in seeing that the surfaces of the tube are quite clean and free from grease, and that the mouth dips well under the mercury in the vessel in which it is placed. Otherwise slow inward diffusion of air may occur along the walls.

In the chapter on the preparation of pure gases we should have liked fuller descriptions of the methods, and more of them, the details in some cases being decidedly meagre and several of the methods recommended being only suitable for the preparation of very small quantities of gas.

The electrolytic preparation of hydrogen and oxygen from dilute sulphuric acid is a method which does not receive the author's commendation for ordinary use, but most of the disadvantages disappear, at least in the preparation of oxygen, if phosphoric acid is taken in the place of sulphuric.

No mention is made of the electrolysis of hydrochloric acid and the preparation of the intensely interesting mixture of chlorine and hydrogen sensitive to light, although this experiment is attended with peculiar difficulties.

On p. 74, reference is made to the "Paris kilogram," an ambiguous and unnecessary term if the now almost universally recognised international kilogram is meant (let us be thankful that there are not as many kilograms as ohms), and on p. 130 we find the statement,

"The results (weighings of gases) are reduced to the values which would have been obtained at sea-level in latitude 45°. They may be reduced to the Paris standard by multiplying by 1·000316."

We fail to see why, after having reached lat. 45° and sea-level, some charm in the local value of gravity should induce us to come back and reweigh the gas at Paris. It may be mentioned here that the very divergent values quoted on p. 74 for the mass of a cubic decimetre of water at 4° ought to be replaced by more modern data, which agree in fixing 999·95 ± ·02 grm. as a much more probable value.

We are glad to see that in the chapter on gas analysis Dr. Travers has weeded out from the many forms of apparatus and methods employed those only suitable for *technical* use, describing only those capable of scientific accuracy, with copious references to the most recent work on the subject. The usefulness of the chapter would, however, have been increased had a description been given of some form of complete apparatus for general gas analysis, such as that of Prof. MacLeod, or one of its later modifications.

We may sum up the chapter on the preparation and properties of the gases of the helium group by saying that it contains practically all that is known on the subject.

Temperature measurement by the gas thermometer is gone into at considerable length; and the convenient and accurate compensated constant-pressure thermometer of Prof. Callendar is illustrated and its working described in detail.

In the chapter on the liquefaction of gases, a full account is given of Dr. Travers' own experiments on the liquefaction of hydrogen, which is a reprint, with additions, of his recent paper in the *Phil. Mag.* This concludes with an account of the cost of these experiments, in which it is stated that, after an outlay of about 250*l.* on the complete plant, an expenditure of about 1*l.* each time covers the cost of making liquid hydrogen.

Anyone familiar with some of the palatial laboratories of many of the physical chemists abroad, visiting for the first time the dingy dwelling of the chemical department at University College, which the school of Ramsay has now made classic ground, could not fail to be surprised at being shown the hydrogen liquefier fitted up in a disused lavatory, and to hope that in the coming London University scheme physical chemistry may find a worthier home.

To return to the book, it appears to be accurately printed, and although we have verified many of the numbers and constants given, the errors we have detected are not numerous.

Among the slips may be pointed out, Kaysir for Kayser; Wülmer for Wüllner; Kirschoff for Kirchoff. Fig. 102, which is repeatedly referred to, appears to be missing.

We may conclude by stating how much a study of the book has emphasised in our own mind the importance of Prof. Ramsay's concluding sentence in the preface he has written directing attention to the lacunæ still remaining in many branches of our knowledge, and by heartily congratulating Dr. Travers on his labours, which have produced a book worthy of a place in the reference library of every student of modern chemistry. J. A. H.

OUR BOOK SHELF.

Tafeln zur Theoretischen Astronomie. By Julius Bauschinger. Pp. 148. (Leipzig: Wilhelm Engelmann, 1901.) Price 12*s.* net.

MOST astronomers are familiar with the very excellent volume entitled "Formeln und Hülfstafeln für Geographische Ortsbestimmungen," by Prof. Th. Albrecht; this work contains in a small compass most of the formulæ and tables required for geodetic work, and the very clear descriptions of the processes involved make the volume a veritable *vade mecum* for those employed on such work.

The volume before us does for "theoretical astronomy," that is astronomy dealing with the determination of the positions and orbits of bodies in space, what the above-mentioned book does for geodetic work, and the main attempt of the compiler has been to bring together in a compact and complete form all that is required by the computer, rendering it unnecessary for him to seek aid from other books. In this class of work the computer has generally to consult more than one volume in which suitable tables for his calculations occur, such as, for instance, the valuable work of von Oppolzer, and in some cases the tables are not of the most convenient form.

The present volume, therefore, serves a most useful purpose, and the arrangement of the tables leaves, so far as can be seen without actually working out a problem, little to be further desired. The tables, which are forty-five in number, are arranged under six subheads. The first of these divisions is devoted to such objects as conversion of time into divisions of arc, mean time into sidereal time, &c., and *vice versâ*. The next is for the determination of the true anomaly from the time and *vice versâ*, for elliptic, parabolic and hyperbolic motion, and here three methods for the solution of Kepler's equation are given; two of them are based on Tietzen's solution and are purely computational, while the third is after the graphical method of Waterston and Dubois and is accompanied by two loose charts.

The third set of tables deals with the part of the problem relating to the determination of the first approximate orbit, in which both Euler's and Lambert's equations are required; while this is followed by tables which serve for the computation of special perturbations and improvement of the elements determined by the first approximation.

The fifth part gives the means for calculating precession, nutation, aberration and parallax, and contains a list of the chief observatories of the world and their coordinates, with data for parallax determination.

The sixth and last section is formed of miscellaneous tables which are of general use in work of this kind; thus we have formulæ and tables for interpolation, differentiation and integration, mechanical differentiation, &c., concluding, amongst others, with mathematical, astronomical and geodetic constants.

All the tables which depend on astronomical constants have been recalculated and based on the Paris Conference constants, while each table is clearly explained and in most cases accompanied by an example worked out step by step.

This book of tables will, with very little doubt, be of considerable service both to the experienced computer and to the student who is working out orbits for the first time. Great praise is due to the compiler who has performed this laborious task with so much care and with such success.

An Elementary Treatise on Alternating Currents. By W. G. Rhodes, M.Sc. (Vict.). Pp. xii+211. (London: Longmans, Green and Co., 1902.) Price 7*s.* 6*d.* net.

MR. RHODES' treatise on alternating currents can hardly be regarded as particularly elementary, since he certainly assumes in his readers a preliminary acquaintance with the principles of the subject. We are inclined to think that although the mathematical parts are good, the treatment on the electrical side, especially in the simpler parts, leaves a good deal to be desired. Thus on p. 23 the quantity $2\pi nL$ is defined as the reactance, whereas a few pages further on (p. 31) this name is used for the fuller expression including self-induction and capacity, without any explanation as to why the same term is used in both cases; the same observations apply to the definition of impedance. One may be pardoned for laying stress on such faults as these, since the subject is at best a difficult one, and without a perfectly sound knowledge of the fundamental ideas, the student will never make much progress.

The author has aimed at using the calculus as little as possible, and, where its employment is inevitable, has given the solution of an equation in the text and the working in the appendix. Many of the problems are solved by vector algebra, to an explanation of the principles of which a short chapter is devoted. The design of transformers and the theory of the synchronous motor and polyphase currents are treated at some length. It is to be noted that although hysteresis is of necessity considered, it is nowhere adequately explained. Another omission is that no description is given of any method of determining the wave form of an alternating current or P.D., although there is a chapter on the subject of alternating measurements. We do not doubt that the book will be found very useful, but its value would be greatly increased by a more careful attention to thoroughness and completeness. M. S.

Cyanide Practice. By Alfred James, Member of the Institution of Mining and Metallurgy, F.G.S., F.C.S. Pp. xii + 174. (London: E. and F. N. Spon, Ltd.; New York: Engineering and Mining Journal Incorporated. Not dated). Price 15*s.* net.

ALTHOUGH there are now a number of books in which some information on the cyanide process can be found, a full and satisfactory description of it has not yet been written, and can hardly be expected until more experience has been gained. Meanwhile, no instalment of the complete account can be more interesting and important than that giving a record of the experience and views of Mr. Alfred James.

Mr. James was the pioneer of the process in South Africa in 1888, and to him belongs the credit of adapting it to the treatment of auriferous tailings at a time when cyanide was in some danger of being set aside for the time owing to the difficulties encountered in the treatment of virgin ores with its aid. When a good start had been made, and the value of cyanide solutions demonstrated, a host of workers took up the task and a vast industry was created on the foundations laid by Mr. James; but the part he played in promoting the prosperity of the Witwatersrand gold mines will always be remembered with gratitude by metallurgists.

As might be expected, the book is full of good things, details of construction of vats and extractor boxes useful to the general manager, hints on extraction and precipitation designed to aid the millman, and hitherto unpublished researches on bromocyanide which will be read with avidity by the chemist. The method of arrangement, however, leaves something to be desired. Some sections consist of papers read at various institutions which have been reprinted almost without change and without much effort to make them part of a coherent whole. The imperfections of the index render it difficult to refer to any particular point, and the only way to avoid missing important details is to make oneself familiar with the whole book, which is, fortunately, tersely written and by no means long. Difficult as it may be, however, to take full advantage of Mr. James's work, no one concerned in the cyanide process can afford to do without the volume which he has produced.

Index Kewensis Plantarum Phanerogarum. Supplementum primum. By Theophilus Durand et B. Daydon Jackson. Pp. 120. (Brussels).

ON the title-page of this, the first supplement to the "Index Kewensis," the name of Monsieur T. Durand, the director of the botanical garden at Brussels, is associated with that of Mr. Daydon Jackson, the author of the original work. Mr. Durand is mainly responsible for the new part, which deals with species and varieties which have been named during the decade 1886–1895. In order to maintain uniformity, the same arrangement is adopted as in the "Index Kewensis." Most of the new plants are tropical, and quite an appreciable addition is due entirely to Kuntze, who has upset several of the ordinarily accepted genera, though for the most part species names are unchanged. This part takes the genera as far as Cymbidium.

It is hardly necessary to point out the importance of keeping a standard work of this kind up to date, and the author has rendered a great service to systematic botanists in bringing out so quickly, considering the great labour involved, this additional record of plant names.

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 Misuse of Coal.

As England has taught the world how to use coal, she ought to think of teaching the world how to use coal without waste. Coal is so plentiful, so cheap; it is so much to the interest of many people that the waste should go on, and the general public, who alone can apply a remedy, are so ignorant of natural science that when, every few years, I draw attention to this subject, I feel my efforts to be hopeless. Nevertheless, you will perhaps allow me to call attention to the fact that in the very best and largest steam-engines less than 10 per cent. of the energy of coal is utilised; in many small engines only 1 per cent. The remaining energy is quite wasted.

In the electric generating station of a city like Manchester, there are engines of 12,000 horse-power, driving tram-cars and house-lights. In a line of battle ship there is more than twice this power. Two new Cunard steamers are, I understand, about to be ordered, each of which will have 48,000 horse-power. The great waste of energy inevitable in all heat engines of the world is therefore enormous.

It is known that when fuel energy is converted into the electric form directly, as in a voltaic cell, more than 90 per cent. of the fuel energy is convertible into the mechanical form, but at present contrivances to do this even in the case of gaseous fuel are too bulky and expensive to compete with heat engines. I wish once more to suggest that an organised attempt be made to convert the energy of coal into electric energy in some form of engine which shall not cost more or have greater weight than a steam-engine of the same power.

For the heating of buildings, Lord Kelvin pointed out long ago that the very law of thermodynamics which makes a heat-power engine inefficient makes it possible to obtain from one unit of energy the effect of 50 or 100 units by direct heating. I know of nothing which so well illustrates the scriptural promise of the seventy and seven fold reward of virtue as this. Discover the energy engine and you multiply your power to heat buildings from coal, seventy and seven times. But how can we make facts of this kind obvious to ordinary men—the men who are said to be educated when they know absolutely nothing of physical science? Even with coal as cheap as it is we might appeal to its selfish users by pointing out that with the new kind of engine a ship would be able to travel ten times as far at full speed as she now can do without coaling.

The world's yearly output of coal recently was 663 million tons. Of this Britain's share was 30½ per cent. If the whole of the energy of Britain's coal for one year could be utilised and charged for at 8*d.* per Board of Trade unit, the price paid in many towns by consumers of electric energy, it would amount to 100 times our national debt. It is to be remembered that the cost of human labour when used most economically is nine times the figure here given.

Here is another fact. Scientific men know of no other store of energy available for man's use than fuel from the earth, except what we may get by the help of the tides or by wind or waterfalls. To depend upon the future discovery of some great store is to act like a spendthrift who knows of no relation whose death will give him more money and yet who goes on wasting his substance. The energy of coal is the foundation of such widespread comfort as we now observe all over the world. To put the matter in a very definite form we may say:—the cost of one Board of Trade unit of energy by the agency of human labour working most economically is seventy pence; the cost of the unit as given out by a large steam-engine in a cotton factory is one farthing; the cost per unit of the coal alone (at 8*s.* per ton) if all its energy were utilised is one one-hundredth of a penny. But when our coal supply is exhausted, when all the races of the world have fought for the waterfalls and places of high tide, the price must go back to the higher figure. The failure of our coal supply is one of the two things neglected by Mr. Wells in his "Anticipations," the recollection of which would have modified all his conclusions. When coal becomes scarce, people will wonder how it was possible for the nations to spend so much money as they all now do, and our grasshopper weight of a national debt will seem to be an unbelievable burden. Seventy pence to a farthing is the ratio of values without and with coal even now, and the ratio ought to be ten times as great, or 2800 to 1.

In sixty years we have greatly destroyed that store of energy which is the foundation of what some of us call civilisation. In another hundred years the English hamlets of contented working folk that have become cities of luxurious people will decay again into hamlets, inhabited by a discontented, poverty-stricken population which will curse its ancestors for their prodigality. They will not curse us for using coal perhaps, but they will know how to economise coal, and so they will curse us for our ignorance. Over and over again have I called attention to the fact that we are wasting the energy-capital of all the inhabitants of the earth for all time to come. The value of human labour gives the normal value of energy, and at this rate we in England are wasting 900 times the amount of our national debt every year. I have dragged this matter into my lectures and papers with and without relevancy many times, and every one of my hearers and readers neglects its significance. Scientific men know it, but they think it useless to try to impress the ordinary citizen, so ignorant of natural science as he is and so unheeding of any kind of danger which was unknown to his forefathers. What annoys me particularly is not so much the selling of my birthright as that I should sell it for such a mere mess of pottage.

To return to my cry for a new invention. Many men have advanced the subject beyond its first principles; they know of directions in which to work with prospects of success. In the animal machine the thing is actually done; but of this machine

the mere conversion of fuel energy into mechanical work is not the most important function, and the machine is very complex. Still, in it we have no heat engine, but the sort of thing we are looking for. I do not wish to set capitalists and patent lawyers against me, and so I will not give my reasons for saying that there is no sufficient temptation for any scientific man to take up the quest. Unless it is taken up as a matter generally recognised to be of national or world-wide importance, there is no more use in tackling the problem than in hunting De Wet with a small army. Many scientific men must combine their efforts in an organised way, freely communicating their ideas to one another and consulting each other as to their experiments. They must be made free from pecuniary cares and assured of great rewards in case of success. I feel sure that if one or two chiefs like Lord Kelvin or Lord Rayleigh were entrusted with the expenditure of a million a year for two or three years by the English nation for the benefit of the world, with power to impress the services of all scientific workers likely to be of use, to make their operations as extended as they pleased, they would bring the invention within reach of the ordinary engineer.

JOHN PERRY.

Birds attacking Butterflies and Moths.

IT was inevitable that the question of birds attacking butterflies would lead to some account of their attacks upon moths. Although I do not believe that any doubt has been thrown upon the keenness and frequency of the pursuit of moths by birds, a few examples of unusual interest deserve permanent record.

About the year 1887 I saw a fine specimen of the Lobster Moth (*Stauropus fagi*) at rest on the lamp-post at the entrance to Norham Gardens, Oxford. So far as I was aware, it was the first specimen which had been noticed in Oxford, and I was anxious to secure it. The moth was gently touched by a stick tied to an umbrella and came fluttering down feebly towards the ground, when, as I ran to catch it, a sparrow dashed across and seized it before it had reached the ground. I chased the sparrow, encumbered with the heavy moth, for some distance, and at first thought it would relinquish the prize. But it soon flew up to the roof of a house and ate the moth in the rain-water gutter.

I am indebted for the second and very remarkable example to Mr. W. Eagle Clarke, of the Edinburgh Museum of Science and Art. He writes, March 1:—"I send you an account of what I think is a somewhat unusual instance.

"In June last, as I was walking at midday along the road which runs close to the shore of Loch Assynt, in north-west Sutherland, a male Oak Eggar Moth (*L. quercus*) dashed past me with the swift irregular flight characteristic of that species. Suddenly a wheatear, a male, gave chase and, after several failures at capture, succeeded, after a clever but trying pursuit, in securing its prey. The body, &c., of the moth was eaten on the road, where I found the wings, the only remains.

"If I had not seen this 'flight' from start to finish, I should not have thought it possible that a wheatear could have been so swift and smart on the wing, for, as you know, an Oak Eggar is not an easy quarry to secure when in flight.

"I have seen a great titmouse capture the white butterfly—*Pieris rapae*—on the wing."

I am sure that any naturalist who is familiar with the flight of the male Oak Eggar will feel all the astonishment which Mr. Clarke expresses at the success of the bird.

The two remaining examples deal with attacks upon the pupæ of moths.

In July, 1900, Mr. A. H. Hamm, of the Hope Department, showed me a number of cocoons of the Lackey Moth (*C. Neustria*), which had just been opened, probably by sparrows, and the pupæ extracted.

The cocoon is tolerably dense, and is probably still further protected by an abundant sulphur-coloured powder which consists of minute crystals of aragonite (calcium carbonate), secreted by the malpighian tubercles of the larva and extruded from the anus before pupation. The cocoons were spun upon the under sides of leaves of black currant and apple, and it was of the highest interest to observe that every one had been opened by the bird pecking a hole in the leaf from the upper side and thus making an aperture in by far the thinnest part of the cocoon. The observation was made in Mr. Hamm's garden in St. Mary's Road, Cowley Road, Oxford.

The last example is equally interesting, but does not deal with the attacks of birds.

Colonel J. W. Yerbury informs me that when collecting on Beown Mountain, Macgillicuddy Reeks, Kerry, on July 21–22, 1901, he found under a stone, at the height of more than 2000 feet, the old winter store of a mouse or possibly a shrew, consisting of eight to ten cocoons of the Emperor Moth (*Saturnia carpini*). Every cocoon had been gnawed through at the base, viz. the end opposite to that from which the moth emerges, and the pupa extracted.

EDWARD B. POULTON.

Oxford, March 6.

Sun Pillars.

ON Thursday the 6th inst. a very fine display of this phenomenon was observed over a considerable area in the west of England, and having regard to Prof. Herschel's interesting letter on the same subject published in NATURE on July 4 last (No. 1653, vol. lxiv. p. 232), perhaps the few facts I have been able to collect may be of interest to some of your readers.

For several days the weather had been exceedingly fine and dry, with hot sunshine and a wind following the sun. The wind on the evening in question had almost died away at sunset; the latter was at 5h. 46m. Greenwich time, and would be about 6h. 5m. here. Close upon 5h. 30m. the light-beam first appeared rising vertically from the sun, which was still visible above a violet-coloured bank of haze; its base did not extend below the sun.

The beam had the appearance of a tall column of very beautiful orange-coloured light brighter in the centre than at the edges; its top must have been quite 20° above the horizon. The sun sank into the haze about 5h. 45m.; the column remained just as bright though reddening gradually until 6h. 20m., and was still distinctly visible at 6h. 40m. It had faded away by 6h. 50m. Faint bands of cloud were visible round the sun, and these sloped from the top of the light-column obliquely downwards in a northerly direction; I also noticed a repetition of the beam on either side of it, though this may have been purely an optical illusion.

I have ascertained that the effect was seen over the whole of Cornwall and Devon, as far east as Salisbury and Taunton, and north as far as Pendine in Carmarthen Bay. Snow has not fallen here for several weeks.

W. H. GRAHAM.

Fowey, March 11.

IN reply to Mr. Knight's inquiry in last week's NATURE (p. 439), he may be referred to many old books, as, for instance, to Moigno's "Répertoire d'Optique Moderne," published in 1847, in the first volume of which he will find a whole section devoted to meteorological optics. The explanation of most of

the phenomena of meteorological optics had, I believe, been worked out by Babinet about ten years earlier.

As to the vertical pillar of light frequently observed in high latitudes after sunset and before sunrise, and occasionally seen in latitudes as low as ours, it may be attributed to spiculæ of ice which, whether isolated or radiating from a centre as in crystals of snow, will assume a horizontal position if they subside through a portion of the atmosphere which is quite free from convection currents. Those of the horizontal spiculæ which are vertically over the cone connecting the spectator's eye and the sun will include some that can directly reflect solar light to his eye, and it is these that produce the phenomenon which was seen by Mr. Knight. The pillar may be expected to be white till the sun gets some distance below the horizon, when it will in succession assume the colours due to the absorption and dispersion of light by the atmosphere.

It can easily be shown experimentally that if the air be free from the minute convection currents which so trouble astronomers (which it seldom is), then subsiding spiculæ of ice will be horizontal. To show this, cut from a sheet of stiff paper a straight, long and narrow strip, and let it fall through the air. The experiment is a pretty one when the strip of paper is thrown out of an upper window on a calm day. The strip falls not lengthwise, but sideways, and spins round its long horizontal axis. The dynamics of this phenomenon have not, I think, as yet been worked out. The explanation would require an investigation of the stream lines surrounding a body rotating as well as progressing through a fluid. It seems to be a problem which might with advantage be proposed to the mathematical research scholars of our Universities.

30 Ledbury Road, W., March 16. G. JOHNSTONE STONEY.

Proofs of Euclid I. 5.

BESIDES the proofs cited by Prof. Bryan (p. 438), another is equally worthy of notice, and requires no construction. The sides of the triangle ABC may be regarded as taken in two orders—

AB, AC and ∠A
= AC, AB and ∠A
∴ ∠ opp. AB = ∠ opp. AC.

This is a variation of the proof by duplication, but avoids this process. As in the case of the proof cited by Prof. Bryan and involving limiting values, the proof given above is not altogether satisfactory for the use of beginners, and is, of course, of no value to the advancing student except as an interesting illustration of method. H. W. CROOME SMITH.

Bristol, March 15.

As Prof. Bryan is discussing proofs of Euclid's I. 5, may I call attention to the way I proved it in my "Foundations of Geometry," namely as a corollary to the equivalent of I. 4? Thus—

"For if AB in the above proof had been equal to AC, the triangle ABC might also have been moved so that AB fell on DF, and AC on DE, and the triangles would have been congruent so. Hence both the angles ABC and ACB would be shown to be equal to DEF, and therefore to each other."

This seems to me far and away simpler than any other proof I know of, and it has the advantage of directing attention to the fact that the proof of I. 4 as often as not involves turning the triangle over in the air, while moving it; so that, for example, the proof would not apply as it stands to spherical triangles. EDWARD T. DIXON.

Racketts, Hythe, Hants, March 16.

THE NATIONAL PHYSICAL LABORATORY.

SOME further account of the National Physical Laboratory, which is being opened by H.R.H. the Prince of Wales, accompanied by H.R.H. the Princess, as these lines go to press, may be of interest to readers of NATURE. A description of Bushy House, with plans, has already appeared; the alterations required to fit it or a laboratory are now complete, and the new buildngs erected for the engineering department are ready or use. The following extracts from the report of the executive committee will indicate what has been done :—

The basement and ground floor of Bushy House have been transformed into a physical laboratory, while the upper floors form offices and a residence for the director. The basement is covered with a brick groining, on which the main building rests, but the more important laboratories are in four large wings, one at each corner, and these have no basement below, thus steady supports are everywhere possible.

One wing, containing the original dining-room and library, has been fitted as an electrical and magnetic laboratory. All iron has been, as far as possible, removed from the structure, and, with a view of preventing a stray magnetic field from any currents which may be used, concentric wiring has been employed for all large currents, while the wires for smaller currents have been twisted.

In this room will be placed the Lorenz apparatus which the Drapers' Company has recently with great generosity given to the Laboratory in memory of the distinguished services to science and to education of the late Principal J. V. Jones, F.R.S., of Cardiff. Along with this there will be other apparatus for the absolute measurement of current and of electromotive force.

Another wing has been fitted for thermometric work. A special study will be made of high-temperature thermometers, and the laboratory owes to the generosity of Sir A. Noble the means for installing a number of electric ovens for testing thermopiles and other instruments for the measurement of temperature up to 1000° or 1200° Centigrade.

In a third wing a metallurgical laboratory has been fitted in which to continue the work begun at the Mint by Sir William Roberts-Austen and the Alloys Research Committee. For this purpose apparatus for cutting and polishing sections and further photomicrographical examination has been obtained. The committee has to thank Mr. Stead for his assistance in arranging this. The fourth wing is fitted as a chemical laboratory. In the basement are a number of constant temperature rooms.

Sir Andrew Noble's fund, referred to in the last report, has provided a measuring machine, a dividing engine and a comparator, which will be placed in some of the basement rooms. In an adjoining room the resistance measurements of the British Association Committee will be continued, while in another, apparatus for the production of liquid air is being set up. The testing of pressure gauges will form an important branch of the work, and for this a mercury column some fifty feet in height has been erected in one corner of the house.

Gas and water have been laid on freely throughout the building—also electricity. A 100-volt circuit is connected to the main dynamo and battery in the power-house, and supplies light. Numerous plug points enable a supply to be taken off for lights for experimental purposes or for small motors. For experimental work a special battery of fifty-five cells has been installed. This is divided into groups of five. Wires run from the switch-board to the various rooms in such a way that one or more of these groups can be switched on to any circuit. Thus voltages between 2 and 110 volts can be obtained as required.

The house is heated on the Webster low-pressure system by steam from a Lancashire boiler in the boiler-house at a distance of about 100 yards. The boiler also supplies steam to one of Parson's 60-kilowatt turbo-generators, which is the main source of power. The power-house also contains an 18-h.p. Crossley gas-engine, driving a 12-kilowatt dynamo by T. Parker and Co. This serves as a stand-by and for charging the main battery of fifty-eight chloride cells.

The engineering laboratory, a building eighty feet by fifty feet, adjoins the power-house. This is divided into two bays; a shaft, driven by a motor supplied by Mather

and Platt, runs along one, and in it will be placed the lathes, drilling machine, planing machine and other tools. The other bay is for experimental work. It is traversed by a 2-ton crane, and will contain a testing machine and machinery for testing steam-pressure gauges, indicators and such instruments.

With regard to gifts to the Laboratory, it has already been mentioned that the Drapers' Company has undertaken to provide the sum of 700*l.* to meet the cost of a Lorenz apparatus, in memory of the late Principal Viriamu Jones. Messrs. Willans and Robinson are providing apparatus for testing steam-pressure gauges and indicators, while in a number of cases very advantageous terms have been granted to the committee by manufacturers of tools and machinery. Lord Rayleigh, Lord Kelvin, Mrs. Hopkinson, and the Syndics of the Cambridge University Press have presented valuable books. Lady Galton has given a valuable astronomical clock with electric contacts, in memory of the late Sir Douglas Galton.

But though much has been done, the Laboratory is far from complete. Rather more than 3000*l.* has been spent on apparatus, but visitors will notice many gaps before the important problems which lie to hand can be fully grasped. Still, it is now possible to make a start, and to show, by the work done with the means at the disposal of the staff, that the Laboratory is fulfilling a need and that it deserves the support of those who are concerned in facilitating the application of science to industry. The pious benefactor, however, who will put it as regards equipment on a footing comparable with the Reichsanstalt is still to seek.

In research work it is hoped that the investigations of the Alloys Research Committee may be continued. Much, though not all, of the apparatus required for this has been purchased; a recording pyrometer, however, must be added to the outfit before it is complete. Prof. Barrett's paper read at the Institution of Electrical Engineers recently showed the importance of the aluminium steels for dynamo and transformer manufactures, and with the kind assistance he then offered it is hoped that a start may soon be made on their investigation.

The measurement of wind pressure is of great importance to engineers; with the help of Sir Benjamin Baker, an investigation will be made into this subject.

In thermometry, the object will be to arrange for the more systematic and ready measurement of the high temperatures met with in industrial undertakings.

As to the commercial testing work which is to be undertaken, the following list will indicate its scope, though until the Laboratory standards have been more thoroughly studied it is hardly possible to do much on a large scale:—

Tests of pressure gauges and steam indicators.

Tests of measuring appliances and gauges for use in engineering shops, &c.

Test of screw gauges.

Tests of thermometers for the measurement of high or low temperature, the platinum thermometer, thermopiles, &c.

Photomicrographic tests on metals, steel rails, &c.

Measurement of the insulation resistance and dielectric capacity of insulators.

Measurement of the electrical resistance of conductors.

Tests of capacity and induction and of various forms of electrical measuring apparatus.

Tests on the magnetic properties of iron, &c.

Standardisation of glass vessels, flasks, burettes, &c., used in chemical laboratories and in various industries—*e.g.* the dairy trade.

Standardisation of weights and scales for laboratory purposes.

Testing of photographic and other lenses.

The director hopes before long to issue a pamphlet giving some account of these various tests, together with a statement of fees charged.

Thus an ample programme has been prepared, and it is interesting to learn on the authority of the director that some slight demand has already shown itself for nearly all the tests enumerated in the list.

PROPOSED ORGANISED RESEARCH ON CANCER.

WE are pleased to learn that a scheme has recently been elaborated in this country for the purpose of systematising and procuring endowment for research upon cancer. In this respect our country is already somewhat behindhand, since a similar organisation has been for some time in full activity in Germany. A large sum of money has been placed at the disposal of Prof. Ehrlich, and a German cancer committee, with Prof. von Leyden as president, is now at work. To this purpose the German Government has already made grants of upwards of 50,000 marks. In America there is a State-subsidised cancer laboratory at the present time, under the direction of Prof. Roswell Park, concerning the work of which some account was given in the *Medical Record* last May. In France, cooperative work upon cancer is also already in progress, a special journal being devoted to the publication of the results.

It will be unnecessary to enter here into the details of the scheme; suffice it to say that any funds will be invested in the names of five trustees, and that the income derived from them will be paid over to a general committee consisting of these trustees and three representatives of the College of Physicians (the president and two censors), three representatives of the College of Surgeons (the president and two vice-presidents), the members of the laboratories committee of the Royal Colleges of Physicians and Surgeons, and one member, to be nominated by the Local Government Board. The general committee will have control of the income of the fund, but concerning the exact method of spending it they will take counsel with an advisory board, which will consist of the laboratories committee of the Royal Colleges and other members chosen in equal numbers by each of the Royal Colleges. It is estimated that the sum of 100,000*l.* will be required for the above purpose. At the present time, funds are conspicuous by their absence.

To the lay mind the term cancer does not imply a well-marked entity; the word is, in fact, occasionally used as synonymous with tumour, meaning, roughly, a swelling or growth where a swelling or growth ought not to be. To the medical mind the term cancer means a special form of tumour which is characterised microscopically by its structure and clinically by its method of growth. This latter is of two kinds, local and general. The local growth consists of an infiltration of the adjacent tissues, the general growth of a dissemination of the particles of the disease which produce growths, conforming in type to the original tumour, in parts of the body more or less remote from the seat of the primary affection. So far as concerns their minute structure, however, tumours growing in the above manner are not all, from the histological standpoint, cancers or carcinomatous. This term has been made by morbid histologists conventionally to designate a definite variety of tumours growing in the above-stated "malignant" manner, viz. those the microscopic structure of which is of the epiblastic or epithelial type. This classification is rendered necessary by the fact that there exists another class of tumours equally malignant, but the minute structure of which is of the connective-tissue or mesoblastic type. These tumours

are termed "sarcomata," a term as meaningless as its congener, carcinoma. We have, then, speaking roughly, two great classes of tumours, the so-called innocent tumours, or those which grow slowly and locally, and the malignant tumours, which grow rapidly and become disseminated all over the body. This latter group, although consisting of two classes, the carcinomata and sarcomata, are generally designated "cancers," and are, no doubt, although, so far as we can ascertain, no specific information is to hand upon the subject, to be the objects of the proposed research.

As very often happens when facts of unmistakable significance are wanting, theories are abundant. This is certainly true of cancer. It must at once be admitted of the theories with regard to the causation of cancer, that although they have no doubt been of great value in assisting what may be termed the crystallisation of histological results, they have, tending as they do rather to express one enigma in terms of another, been of little value from the absolute practical standpoint. Six distinct theories have been put forward concerning the pathogenesis of cancerous growths. Perhaps one of the most generally accepted is Prof. Virchow's theory that these growths are caused by injury or chronic mechanical irritation. There can be no doubt that cancerous growths very frequently affect the parts of the body, either external or internal, which are most frequently subjected to some kind of irritation. Cancer of the tongue in clay-pipe smokers or in the subjects of rough and uneven teeth, cancer of the scrotum in chimney sweeps, due to chronic irritation of the part by soot, &c., cancer of the breast, of the arms in paraffin and tar workers, of the two ends of the stomach, especially apparent in individuals who masticate imperfectly, can all be cited as showing the predilection of cancerous growths to parts of the body exposed to constant or intermittent irritation. Perhaps of all the numerous common factors in cases of cancer, chronic irritation is the most constant. It cannot, however, be regarded as a universal or even adequate explanation of the disease, for, as Cohnheim has pointed out, in 86 per cent. of all the cases irritation apparently plays no part. Prof. Cohnheim regards cancerous growths as being due to the abnormal proliferation of embryonic remnants. He assumes that in the development of the individual from the embryo, more cells are produced than are required for the building up of the organ concerned. There thus remains an embryonic cellular remnant. These embryonic cells remain always possessed of one characteristic of this variety of cell, viz. an unlimited capacity for proliferation. These remnants may remain quiescent, and then nothing more is heard of them; they may, however, under the influence of certain conditions, assume active growth, and may thus constitute malignant tumours. There can be no doubt that this theory explains many of the features of cancerous growths, and is greatly supported by the fact that, speaking generally, new growths are prone to occur in parts of the body which are the seats of complicated embryonic development. We have, however, some actual knowledge of embryonic remnants in the so-called epithelial pearls which are fairly frequently found in the tonsils, and it must be admitted that these organs are rarely the seats of malignant growths. Further, in Cohnheim's theory the actual cause which stimulates the growth of the embryonic remnant is not defined except in the most general terms, viz. as a condition of malnutrition of the surrounding tissue.

The obvious similarity between malignant growths and the so-called infective granulomata has led many observers to the view that the former disease must, like the latter, have a parasitic origin. The analogy between these two classes of affection is perhaps the greatest when we take tuberculosis as the type of the infective malady. Tuberculosis at first local, confined, for instance, to a given part of one organ, produces secondary infection in the adjacent lymphatic glands by means of the lymphatics, and subsequently from these tubercular material may gain entrance into the general circulation, and being carried by it hither and thither may become implanted in the most remotely situated organs and produce tuberculosis of them. In the case of cancer there is, too, always a primary focus which is strictly local, and in this case also the lymphatic vessels carry the carcinomatous material to the adjacent glands and from them either by means of the general lymphatic system or the general circulation, carcinoma of remote organs may ensue. When we come, however, to examine this analogy, we find that it is more apparent than real. Tuberculosis can readily be conveyed from animal to animal; this certainly is not the case with cancer. It is true that examples of what may be termed the auto-inoculation of cancer in man are not uncommon; for instance, in the case of adjacent parts of the body, cancer of the one may spread to the other; this probably simply means that the cancerous tissue of the one organ becomes ingrafted upon the other. This condition is often referred to as "contact cancer." Ebert has collected twenty-three such cases. The actual infectivity of cancer, using this term in the ordinary sense, is at present doubtful, although several instances are recorded of what may perhaps best be expressed by the French term, "cancer a deux." Nineteen such cases are given by Behla; in most instances the persons affected were man and wife. Some instances are also on record of surgeons inoculating themselves accidentally with cancer from the cancers of patients upon whom they were operating.

The similarity between malignant disease and tuberculosis has led numerous investigators to seek for an organism which would bear the same causative relation to cancer as the tubercle bacillus does to tuberculosis. Carcinomata have received more attention at the hands of these investigators than sarcomata. Into the details of these most interesting researches the space at our command forbids us to enter. The main point of difference between the adherents of the parasitic theory of the origin of cancer and their opponents centres upon the significance of certain undoubted microscopic appearances, chiefly of the growing portions, of cancerous growths. Some observers maintain that these microscopical appearances represent an organism of a protozoic type, others regard them as due to degeneration of the cancer cells. The majority, however, of microscopists do not regard the presence of a parasite in cancerous growths as proved. In the case of sarcomata, the parasite is supposed to be, not of animal, but of vegetable origin, probably a torula.

If we turn from the study of the hypothetical cancer parasite to a consideration of the influence of general climatic conditions upon the incidence of cancer, we shall be treading upon more certain ground. The existence of so-called "cancer houses" seems to rest upon very strong evidence. In one instance, six persons within twenty-six years died of cancer in two houses that were under one roof and had a common drainage and water-supply. The inhabitants affected were for the most part unrelated to each other. So intimate appears to be the connection between the existence of cancerous disease and locality that so-called "cancer fields" have been described. These are found in "sheltered and low-lying vales traversed by fully formed and seasonably flooded rivers and composed of the more recent argillaceous formations." Districts, on the other hand, which possess the lowest cancer death rate are generally more or less elevated areas composed of the oldest rocks, especially limestone. The difference between the death rates from cancer in different regions in north Germany

is very marked. In certain neighbourhoods cancerous disease is responsible for one in every hundred deaths, whereas in others one in every thirty-three deaths is due to this cause.

Concerning the—from the public standpoint—most interesting question whether or not cancer is on the increase, there seems to be some difficulty in giving an unequivocal answer. That the mortality statistics show an increase is certain, but increased longevity and increased accuracy of diagnosis are disturbing factors in the drawing of inferences and have led many statisticians to regard this increase as more apparent than real. So far as the United Kingdom is concerned, the class of cancerous disease showing the most marked increase is that of the digestive organs, and this has led to the formulation of hypotheses with regard to the relation between the increase of meat-eating and the increase of cancer. The greatest note of alarm with regard to the future of cancer comes from America. It is estimated that in Buffalo during the last fifty years the death rate from cancer has increased five-fold, and that if this increment is maintained, at no very distant date this disease will be responsible for more deaths than tuberculosis, typhoid fever and small-pox all put together.

From the above paragraphs, which must be regarded rather in the sense of jottings of facts, the interest and the importance of this subject will be evident. It seems, further, that the mere microscopic examination of malignant growths has already yielded up to the observer almost all the information it can do, and that it is in the direction of pathological experiment that new and important truths should be sought for, and will probably be found. With the history of the recent progress of the treatment of zymotic diseases before us, doubtless the factors possibly concerned in cancer immunity will not escape the attention of investigators. It is sincerely to be hoped that the public will respond liberally to the call which is being made upon them for funds to defray the expenses necessarily required for an investigation at once so time-consuming and so important.

F. W. TUNNICLIFFE.

THE OWENS COLLEGE JUBILEE.

THE series of functions at the Owens College, Manchester, last week, in celebration of the jubilee of the foundation of the College, was carried out with complete success. Prof. S. Hickson was master of the ceremonies, and to him, assisted doubtless by the harmonious cooperation of many others, the greatest credit is due.

The programme on March 12 commenced with the opening of the beautiful Whitworth Hall by the Prince of Wales. The Duke of Devonshire, as president of the College, eulogised the high aims and ideals of John Owens, the founder, in eloquent terms. The Prince of Wales urged on the citizens of Manchester not to be content with the magnificent results of the past liberality of such benefactors as Owens, Beyer, Christie, and Whitworth, but to follow them in liberal support and extension of the College. He pointed out that "the work of an institution of this nature must continually expand; and it must not be forgotten that its material resources must also expand as the work grows." He appealed most forcibly to the generous municipal life and patriotism to enable the College "to keep abreast of the ever-growing demands of modern life."

Sir Richard Jebb and Principal Rücker delivered admirable addresses upon the influence which the College has exerted upon progress in literature and science. The ceremony showed convincingly that the Whitworth Hall justified its dignified beauty of design, by conveniences of access and arrangement and most favourable acoustic qualities. The conversazione in the evening afforded the foreign delegates an opportunity of seeing the Manchester Museum, the whole of the Arts and Science Departments, and the new Christie Library opened four years ago.

On March 13 the actual jubilee celebration was held. Nearly one hundred delegates from academies, universities, colleges and learned societies at home and abroad came forward to present the congratulations entrusted to them and to receive the grip of greeting from the president of the College. The principal proposed the vote of thanks to the delegates, and dwelt on the regretted absence from their number, through illness, of his predecessor, Dr. Adolphus Ward, master of Peterhouse, and of Sir Henry Roscoe, to whom the College is deeply indebted in every way. Prof. Harold Dixon, in seconding the motion, confined himself to the followers of his own science, chemistry, and its sister, physics, and noted with pride the attainments of such as were present as delegates.

Earl Spencer, Chancellor of the Victoria University, then took the chair and admitted the distinguished recipients of honorary degrees. The public orators were the principal. Profs. Wilkins, Schuster, Young, Tout, and Lamb, and Dr. Hiles. Prof. Schuster's presentations were notable for their epigrammatic terseness and point; we may cite his presentation of Dr. Glaisher: "His mind was raised to infinite heights by his mathematical genius; it was brought back to earth by his love of the stars."

An informal "physics colloquium" in the laboratory afforded Prof. Becquerel the opportunity of demonstrating some of the remarkable properties of radium and showing by shadow-photographs the analysis of the various kinds of rays it emits. Profs. Voigt and Nernst also gave interesting communications.

In the evening the court, the teaching staff and the delegates dined together in the Whitworth Hall. This function was a private one.

The students who had assisted as spectators on Wednesday and Thursday organised a torchlight procession followed by a smoking concert on Friday evening. Since then the shadows of the terminal examination have fallen on the College.

The following extracts from the complete reports of the ceremony given in the *Manchester Guardian* are of interest:—

The Duke of Devonshire, president of the College, in the course of his opening remarks, said that the idea of the founder was to provide higher education in such branches of learning and science as are usually taught in the English universities. The original idea was thus education of the university type, such as that which had prevailed at the old Universities of Cambridge and Oxford.

The foundation of the College coincided nearly in time with great discoveries in science, and at the same time with inventions which provided the means of using those discoveries for the purpose of industry, and it is these discoveries which have stimulated interest in those studies of natural science in which Owens College has been preeminently distinguished. This is the interest to which, in the main, Owens College has been indebted for its success. Students have no doubt been attracted by the eminence of some of its teachers from all parts of the country, but, in the main, those students have been drawn from Manchester and its immediate neighbourhood. They have come here doubtless with the desire, with the hope, of acquiring knowledge, that knowledge and training which would be of practical use to them in the future occupations of life. But, at the same time, Owens College has never been content to limit the range of its teaching to one or two subjects or one set of subjects. It has never been content to be merely a medical or a legal or a technical college, but it has set before itself the aim of teaching—of a true university type of teaching—which shall embrace all branches of knowledge.

The address from the College to the Prince of Wales was then read by the principal, and in his reply His Royal Highness remarked:—

"On this first jubilee-day of your College the question may be fairly asked whether it has fulfilled the object of the founder. We are told that his idea was to provide, in a great centre of population, commerce and industry, 'higher education in such branches of learning and science as were usually taught in the English universities.' Those who joined with Mr. Owens in this scheme recognised that in the great commercial centres there was both the opportunity for and the need of something in the nature of real university life. Perhaps the best proof of the wisdom of the policy adopted in the case of Owens College is the fact that in nearly all the largest towns of the country there have been founded during the last thirty years colleges to a very large extent on similar lines. Owens College has sent many teachers, not only to these, but to the old Universities of Oxford and Cambridge. And we may also, on this jubilee-day, take stock of those influences which have been instrumental in thus successfully developing and carrying out the original scheme of the founders. Will Owens College ever cease to venerate the names of Owens, Beyer, Christie, Whitworth, and other noble benefactors to whose munificence is chiefly due her creation, endowment and material prosperity? Can she ever be sufficiently grateful to those great teachers and students who have not only by their genius and force of intellect maintained in the College a high standard of learning, but also by their personal example have helped to form the characters and guide the lives of those who have been so fortunate as to come under their influence? Amongst these former eminent leaders, two—Dr. Ward and Sir Henry Roscoe—are, I am sorry to say, prevented by illness from taking part in to-day's ceremony. But great as have been these different forces in building up this vast and important educational machinery, they would not be sufficient without the strength and sustenance which has been secured by local patriotism and local enthusiasm. I feel sure that Owens College may always count with confidence upon a generous local municipal support to enable it to keep abreast of the ever-growing demands of modern life, whether it be in the arts, in science, or other departments of a liberal education."

In connection with the celebration, the honorary degree of D.Sc. was conferred by the Victoria University upon the following distinguished men of science:—Presented by Prof. Young, Dean of the Medical Department: Sir Thomas Barlow, Sir J. S. Burdon Sanderson, Sir W. S. Church, Mr. H. G. Howes and Prof. Simpson. Presented by Prof. Schuster: Prof. Becquerel (Paris), Prof. Chodat (Geneva), Prof. G. Carey Foster, Dr. J. W. L. Glaisher, Principal E. H. Griffiths, Principal Hicks, Dr. E. W. Hobson, Prof. G. B. Howes, Prof. W. Jack, Principal Lodge, Prof. Nernst (Göttingen), Prof. Poynting, Prof. Tilden, Prof. Voigt (Göttingen), and Prof. Marshall Ward. The honorary degree of M.Sc. was conferred upon Mr. C. Bailey, Mr. Francis Jones and Mr. J. H. Reynolds.

CELEBRATION OF THE TWENTY-FIFTH ANNIVERSARY OF THE JOHNS HOPKINS UNIVERSITY.

THE twenty-fifth anniversary of the foundation of the Johns Hopkins University was celebrated at Baltimore last month. The commemorative address delivered by Dr. D. C. Gilman, for twenty-five years president of the University, and now president of the Carnegie Institution, is published in *Science*, together with the address delivered by Prof. Remsen upon his inauguration as president of the University. The assembly was one of the most noteworthy that has been gathered together in America, being composed of leaders in many branches of intellectual activity. In the course of the ceremonies an address, signed by more than one thousand alumni of the university and others, was presented to Dr. Gilman. We give extracts from the addresses delivered by Dr. Gilman and Prof. Remsen.

In the course of his address Dr. Gilman said:—

When this university began, it was a common complaint, still uttered in many places, that the ablest teachers were absorbed in routine and were forced to spend their strength in the discipline of tyros, so that they had no time for carrying forward their studies or for adding to human knowledge. Here the position was taken at the outset that the chief professors should have ample time to carry on the higher work for which they had shown themselves qualified, and also that younger men, as they have evidence of uncommon qualities, should likewise be encouraged to devote themselves to study. Even those who were candidates for degrees were taught what was meant by profitable investigation. They were shown how to discover the limits of the known; how to extend, even by minute accretions, the realm of knowledge; how to cooperate with other men in the prosecution of inquiry; and how to record in exact language, and on the printed page, the results attained. Investigation has thus been among us the duty of every leading professor, and he has been the guide and inspirer of fellows and pupils, whose work may not bear his name, but whose results are truly products of the inspiration and guidance which he has truly bestowed.

The biological laboratory, the first establishment of its kind in the United States, has carried forward for many years the study of marine life at various points on the Atlantic and has published many important memoirs, while it has trained many able investigators now at work in every part of the land. Experimental psychology was here introduced. Bacteriology early found a home among us. The contributions to chemistry have been numerous and important. Here was the cradle of saccharine, that wisely diffused and invaluable concentration of sweetness, whose manufacturers unfortunately do not acknowledge the source to which it is due. In the physical laboratory, light has been thrown upon three fundamental subjects—the mechanical equivalent of heat, the exact value of the standard ohm, and the elucidation of the nature of the solar spectrum. For many years this place was the chief seat in this country for pure and advanced mathematics.

I cannot sit down without bringing to your minds the memories of those who have been with us and have gone out from us to be seen no more: Sylvester, that profound thinker devoted to abstractions, the illustrious geometer whose seven prolific years were spent among us and who gave an impulse to mathematical researches in every part of this country; Morris, the Oxford graduate, the well-trained classicist, devout, learned, enthusiastic and helpful, most of all in the education of the young; accomplished Martin, who brought to this country new methods of physiological inquiry, led the way in the elucidation of many problems of profound importance, and trained up those who have carried his methods to every part of the land; Adams, suggestive, industrious, inspiring, versatile, beneficent, who promoted, as none had done before, systematic studies of the civil, ecclesiastical and educational resources of this country; and Rowland, cut down like Adams in his prime, honoured in every land, peer of the greatest physicists of our day, never to be forgotten in the history of physical science. I remind you also of the early student of mathematics, Thomas Craig, and of George Huntington Williams, the geologist, whose memory is cherished with admiration and love. Nor do I forget those who have here been trained to become leaders in their various departments throughout the country. One must be named, who has gone from their number, Keeler, the gifted astronomer, who died as the chief of the Lick Observatory in California, whose contributions to astronomical science place him among the foremost investigators of our day; and another, the martyr Lazear, who, in order that the pestilence of yellow fever might be subdued, gave up his life for humanity.

Prof. Remsen chiefly dealt in his address with the development of the university idea in America, and showed that the noteworthy characteristic of educational work in recent years is the philosophical faculty in the universities and the surprisingly rapid increase in the attendance upon the courses in such faculties. He remarked:—

In 1850 there were 8 graduate students in all the colleges of America. Of these, 3 were enrolled at Harvard, 3 at Yale, 1 at the University of Virginia and 1 at Trinity College. In 1875 the number had increased to 399. In 1900 the number was 5668. At present the number cannot be far from 6000.

In order that these facts may be properly interpreted, we should know how many Americans are studying in foreign

universities. The records show that in 1835 there were 4 American students in the philosophical faculties of German universities; in 1860 there were 77; in 1880, 173; in 1891, 446; in 1892, 383; in 1895, 422; and in 1898, 397.

These figures show clearly that the increase in the attendance at American universities is not accounted for by a falling off in attendance at German universities. On the other hand, they do show that for the last ten years at least there has been no increase in the attendance at German universities, but rather a slight decrease.

Six thousand students are, then, to-day pursuing advanced courses in American universities, while not longer ago than 1875 the number was only about 400. In this connection it must further be borne in mind that during this period the colleges have not relaxed in their requirements. The tendency has been in the opposite direction. So that it means to-day more rather than less than it did in 1875 to be a graduate student. That there is an increasing demand for university work is clear, and it seems to be destined to play a more and more important part in the development of educational methods.

University work is not something apart, independent of other kinds of educational work. It is a necessary part of the whole system. It affects not only the colleges, but schools of all grades, and must, therefore, have a profound influence upon the intellectual condition of the whole country.

But the universities are also doing another kind of work of importance to the country. Through their specially prepared men they are doing something to enlarge the bounds of knowledge. To be sure, such work is also being done to some extent in colleges and elsewhere, but the true home of the investigator is the university. This work of investigation is as important as the work of training men. What does it mean? All persons with healthy minds appear to agree that the world is advancing and improving. We see evidences of this on every side. Those results that appeal most strongly to mankind are, perhaps, the practical discoveries that contribute so much to the health and comfort of mankind. These are so familiar that they need not be recounted here. If great advances are being made in the field of electricity, in the field of medicine, in the field of applied chemistry, it is well to remember that the work that lies at the foundation of these advances has been done almost exclusively in the universities. It would be interesting to trace the history of some of these advances. We should find that in nearly every case the beginning can be found in some university workshop where an enthusiastic professor has spent his time prying into the secrets of nature. Rarely does the discoverer reap the tangible reward of his work—that is to say, he does not get rich—but what of it? He has his reward, and it is at least a fair question whether his reward is not higher than any that could be computed in dollars and cents.

The material value to the world of the work carried on in the university laboratories cannot be over-estimated. New industries are constantly springing up on the basis of such work. A direct connection has been shown to exist between the industrial condition of a country and the attitude of the country towards university work. It is generally accepted that the principal reason why Germany occupies such a high position in certain branches of industry, especially those founded upon chemistry, is that the universities of Germany have fostered the work of investigation more than those of any other country. That great thinker and investigator, Liebig, succeeded during the last century in impressing upon the minds of his countrymen the importance of encouraging investigations in the universities, and since that time the German laboratories of chemistry have been the leaders of the world. In Germany the chemical industries have grown to immense, almost inconceivable, proportions. Meanwhile the corresponding industries of Great Britain have steadily declined.

What I want to make clear is that universities are not luxuries, to be enjoyed or not, as we may please. They are necessities. Their work lies at the very foundation of national well-being.

The best thing we can do for our students is to give them good professors. Sumptuous laboratories, large collections of books and apparatus, extensive museums are well enough. They are necessary, no doubt. But I fear they are too much emphasised before the public. A university is, or ought to be, a body of well-trained, intelligent, industrious, productive teachers of high character provided with the means of doing their best work for their students, and therefore for the world.

NOTES.

PROF. WINOGRADSKY, of St. Petersburg, has been elected a correspondant of the Paris Academy of Sciences, in the Section of Rural Economy.

THE seventy-fourth meeting of the German Association of Naturalists and Physicians is this year to be held on Austrian soil, Carlsbad being the town selected, and the date September 21 to 27. The arrangements will be generally the same as those introduced at Hamburg last year, but it has been decided to add a new division to the medical group—the history of medicine—so that the scientific side will be represented by eleven divisions, as before, and the medical by seventeen.

THE following are among the lecture arrangements at the Royal Institution, after Easter:—Dr. Allan Macfadyen, three lectures on recent methods and results in biological inquiry; Prof. Karl Pearson, three lectures on the laws of heredity, with special reference to man; Prof. Dewar, three lectures on the oxygen group of elements; and Dr. A. Smith Woodward, three lectures on recent geological discoveries. The Friday evening meetings will commence on April 11, when Prof. Dewar will deliver a discourse on problems of the atmosphere. Succeeding Friday evening discourses will be delivered by Dr. J. Mackenzie Davidson, Sir Robert Ball, Sir Benjamin Baker, Mr. A. E. Tutton, and other gentlemen.

WE regret to see the announcement of the death of Sir Richard Temple, Bart., M.P., F.R.S., whose personality was well known in scientific and educational circles. He was vice-chairman of the School Board of London for three years from 1885 and afterwards chairman of the finance committee of the Board. He was also president of the Social Science Congress held at Huddersfield, and the author of several works on Indian and Eastern topics.

THE death is announced of Mr. Robert Pendlebury, fellow of St. John's College, Cambridge, and well known by his mathematical work. Mr. Pendlebury graduated in the mathematical tripos of 1870 as senior wrangler. He also graduated at the University of London, obtaining the senior University scholarship for mathematics and natural philosophy. He was in due course elected to a fellowship at St. John's, and for many years was one of the college lecturers in mathematics. He was also University lecturer in mathematics, but recently resigned all his appointments. He had been an examiner for the mathematical tripos on several occasions, and for some time a member of the Special Board for Mathematics.

WE learn from the *Victorian Naturalist* that the Central Australian expedition under the leadership of Prof. Baldwin Spencer and Mr. F. J. Gillen reached the Macarthur River, Northern Territory, but was detained at Borroloola, a small township about 50 miles from the mouth of the river, owing to the foundering of the steamer which should have taken them on to Port Darwin as previously arranged. The matter of affording the expedition some relief was brought before the Commonwealth Parliament without result. However, the Premier of Victoria (Hon. A. J. Peacock) placed himself in communication with the Queensland Government, and it was arranged to send a small steamer from Normanton and bring the party on to that port, from whence there is frequent communication with eastern Australia.

IT is announced in the *Times* that the two Royal medals of the Royal Geographical Society have been awarded to Sir F. D. Lugard, for his African explorations and surveys, and to Major Molesworth Sykes, for his journeys in Persia, extending over nine years, and his valuable studies of the geography of the country. The other awards of the society have been made

as follows:—The Murchison grant to Mr. J. Stanley Gardiner, for his researches in Funafuti Island in the Pacific and the Maldive Islands in the Indian Ocean; the Gill memorial to Mr. G. G. Chisholm, for the services he has rendered during twenty-five years to geographical education by text-books of various kinds, atlases and lectures, all of a high standard of value, as well as for his geographical investigations, among other subjects into cataracts and waterfalls, and on the sites of towns; the Back grant to Lieut. Amdrup, of the Danish navy, for his two voyages of exploration to the east coast of Greenland, during which he surveyed and mapped in detail much of the coast hitherto unknown or imperfectly mapped; the Peek award to Mr. J. P. Thomson, the founder of the Queensland branch of the Australian Geographical Society, who, by his writings and in other ways, has done much to promote the interests of geography in Queensland.

THE Naples Academy (mathematical and physical section) has awarded the prize for natural sciences for 1901 to Dr. Marussia Bakunin, the authoress of six printed papers dealing with stereochemistry. The subject announced for the next award (entries closing June 30, 1903) is the formation of urea in the animal organism.

THE prize awards of the Reale Istituto Lombardo for the year 1901 are as follows:—Triennial medals to Prof. Giuseppe Sartori, of Brescia, for preparation of butter with acidified cream, and to Pietro Gamberini, of Milan, for photographic apparatus. Under the Brambilla foundation, a gold medal and 1000 lire to the Società del Laminatojo di Malavedo for the production of soft steel, a similar award to Franchi e Griffin for the wheels of tempered iron (suitable for tramcars and other rolling stock) made by the Griffin process, and a gold medal and 500 lire to Turrinelli and Company for their introduction into Milan of a service of public automobiles worked by electricity. A Fossati foundation award of 1000 lire to Dr. Carlo Martinotti, of Turin, for his macro- and micro-scopic researches on the encephalus of the higher animals. Pizzamiglio foundation prizes of 1500 lire to Dr. Alfredo Piazzi, of the University of Turin, and of 750 lire to Dr. Guido Jona, of Savona, for essays on secondary education. Under the Tommasoni foundation, for studies of the life and works of Leonardo da Vinci, awards of 1000 lire to each of the three competitors, comprising Dr. N. S. Scognamiglio, Prof. G. B. de Toni and Edmondo Solmi.

THE number of the *Rendiconti* of the Lombardy Institution containing the announcements of prize awards also gives a list of future subjects for prizes. Of the prizes of the Institution, that for the present year (entries closing March 31, 3 p.m.) is for a toponomastic exploration of some district of Lombardy; that for 1903 is for some original contribution to our knowledge of the theory of transformation-groups as founded more particularly by Liè. The two triennial medals for 1903 will be offered, as usual, for improvements in the agriculture and in the manufacturing industries in Lombardy. For the Cagnola prizes, the subjects selected by the Institution are, for 1902 (entries closing April 1), the study of the effects of the gases emanating from various manufactories on the growth of cultivated plants, and for 1903, a monographic study of hypophysis. The four subjects selected by the founder for the remaining Cagnola prizes deal with the the cure of pellagra, the nature of miasma and contagion, aërial navigation, and the prevention of forgery, and in connection with the second subject it is suggested in a footnote that competitors might deal with prophylactic measures against malaria considered in connection with our present knowledge of the biology and mode of diffusion of the microbe of this disease. The Brambilla prize is offered for improvements in the manufactories of Lombardy. The Fossati prize for 1902 is for macro- and micro-scopic researches on the encephalus of the higher animals, for 1903 on the nuclei of origin or termination of the cranial nerves, and for 1904 on the localisation of certain cerebral centres. The Kramer prize, confined to Italian engineers, is offered for a report on systems of electric traction. The Secco-Comneno prize is for a description of the Italian natural phosphatic deposits and their practical uses (entries closing April 30, 3 p.m.). A prize is offered under the Pizzamiglio foundation to Italians for an unpublished manuscript on the influence of modern socialistic doctrines on private rights. Ciani prizes are offered for popular Italian literary works, a triennial Zanetti prize (entries closing March 31) is offered to an Italian pharmaceutical chemist who shall obtain a result which is considered of use in the progress of pharmaceutical and medical chemistry, and a Tommasoni prize for 1905 for a study of the life and works of Leonardo da Vinci.

THE thirteenth session of the International Congress of Americanists will be held in the American Museum of Natural History, New York City, October 20-25. The object of the Congress is to bring together students of the archæology, ethnology and early history of the two Americas, and by the reading of papers and by discussions to advance knowledge of these subjects. Communications may be oral or written, and in French, German, Spanish, Italian or English. The papers presented to the Congress will, on the approval of the Bureau, be printed in the volume of the *Proceedings*. The subjects to be discussed by the Congress relate to:—(1) The native races of America, their origin, distribution, history, physical characteristics, language, inventions, customs and religions; (2) the history of the early contact between America and the Old World. All persons interested in the study of the archæology, ethnology and early history of the two Americas may become members of the Congress by signifying their desire to Mr. Marshall Saville, general secretary of the Commission of Organisation, American Museum of Natural History, New York, and remitting either direct to the treasurer (Mr. Harlan I. Smith, American Museum of Natural History) or through the general secretary, the subscription of three dollars. Mr. Morris K. Jesup is president and the Duke of Loubat vice-president of the Commission of Organisation.

THE Government Report of the Committee on Acetylene Generators, which has just been issued by H.M. Chief Inspector of Explosives, shows that the acetylene industry has attained a position of no little importance. Consisting of some thirty pages, the Report, which is the outcome of the work of a strong committee, contains some valuable tabulated results of tests on forty-six specified generators, showing their gas production, efficiency, and maximum pressure in the generating chamber and in other parts of the plant. It speaks very highly for the industry that every one of these generators sent in for examination has been reported by the Committee to be satisfactory. We share the opinion of the Committee that many of the generators on the market are too complex in construction, and when prime cost, space, loss of water and of gas by solution are not important considerations, we agree with the view that the non-automatic generator, on account of its certainty and simplicity, is to be preferred to the automatic type. A list of what the Committee consider the conditions which a generator should fulfil in order to be considered safe should be of great value to those engaged in the design of acetylene plant. The only thing to which exception may be taken is a limit of five inches water pressure suggested for the gas in the service mains; by raising this limit to six or seven inches, the possibilities of using the gas for heating purposes would be greatly increased, and, as we believe that it is generally admitted that under pressures of less than two atmospheres there is no danger of spontaneous decomposition, such an increase does not seem

objectionable, though a three to four inch limit might be imposed for lighting purposes alone. We should like to have seen some remarks upon the purification of the gas and the ventilation of buildings in which it is used in an unpurified condition. Two-thirds of the Report is devoted to the description, with many illustrations, of the types of generators tested. This is valuable as a summary of the catalogues of various makers, but we wish the Committee had seen its way to make some criticisms upon these various types, as was done some time ago by those responsible for the exhibition of generators which was held at the Imperial Institute.

AN advance proof of a Parliamentary paper, received from the Home Office, shows that the total output of coal of the United Kingdom in the year 1901 amounted to 219,037,240 tons, as compared with 225,170,163 tons in the preceding year. The outputs of some other minerals were as follows, the numbers representing tons:—copper ore and copper precipitate, 6792; iron ore, 1,671,025; ironstone (worked under Coal Mines Regulation Acts), 6,849,926; lead ore, 32,552; rock salt, 151,348; tin ore (dressed), 6542; zinc ore, 23,582.

PROF. HERDMAN has written to Mr. I. C. Thompson to say that his investigation of the pearl fisheries of the Gulf of Manaar is being greatly facilitated by everyone interested in it at Ceylon. A steamer—the *Lady Havelock*, of three hundred tons—has been chartered, and a start was made at the end of January. Dr. A. J. Chalmers has given Prof. Herdman the use of a room in his laboratory at Colombo, and Mr. J. C. Willis has offered a work place in his laboratory at the magnificent Botanic Gardens at Peradeniya. Prof. Herdman adds:—"I found up country at Anurhadapura (one of the 'buried cities' of Ceylon) the two Germans, Dr. Paul and Dr. Fritz Sarasin, who have been exploring for years in Ceylon, and were the only people who could give me information about Trincomalee, where I wish to dredge. Finally, I met Prof. Alex. Agassiz, just returned from his expedition to the Maldive archipelago, and he kindly lent me 600 fathoms of especially strong and flexible steel rope, which will be a valuable addition to our tackle. Prof. Agassiz, you will be interested to hear, says he has had a most successful trip, and has secured all the information, photographs and specimens of the coral reefs that he desired. He says the Maldives are the last of the great coral archipelagoes which he had set before himself to examine, and that now he is prepared to write his book on the general subject, 'Coral Reefs and Islands.' There can be no doubt that he has a much more extended personal knowledge of the reefs of the world than Darwin, Murray, or any other previous writer."

AN interesting description of an experimental locomotive appears in the *Times* of March 12. The boiler is an entire departure from ordinary practice; in fact, it may be called a water-tube boiler applied to the locomotive. To Mr. Dugald Drummond, of the London and South-Western Railway, is due the credit for this innovation, and it will be interesting to watch its development. Mr. Drummond has long experimented with water-tubes in the fire-box of the ordinary locomotive with much success, a system originally patented by Mr. W. S. Smith, of the North-Eastern Railway. The modified boiler consists of an ordinary locomotive boiler shell and an ordinary shaped fire-box, but in place of the large number of tubes usually used, one large flue-tube is fitted and this contains many water-tubes; there are also water-tubes in the fire-box. It will, therefore, be seen that the products of combustion on their way from the fire-box to the smoke-box must pass through the large flue-tube and encounter the many water-tubes in it. The locomotive fitted with this boiler has been working the west country expresses between Waterloo and Salisbury with gratifying results. Steam is stated to be maintained with ease. The coal consumption recorded with a train of twelve carriages was under 29 lbs. per mile; it would have been more satisfactory, however, had the weight of the train been stated, because the consumption is decidedly low. This type of boiler should be of much use on locomotives of the ten-wheeled description. The excessive length of ordinary tubes required in this class is out of all proportion, from a heating-surface point of view, such engines having tubes nearly 16 feet long and only 2 inches in diameter, whereas with Mr. Drummond's new boiler a long barrel would be a decided advantage. It is evident that very perfect combustion is possible; the gases are well mixed in the large flue and the flame is less likely to be extinguished on its way to the smoke-box.

A PAPER by Mr. T. R. Rao on the Yánádis of the Nellore district, Madras Presidency, appears in the *Bulletin* (vol. iv. No. 2) of the Madras Government Museum, from which the accompanying illustration of a method of making fire has been reproduced. To produce fire by friction in this way, the Adivi or forest Yánádis prepare two sticks—one short, the other long. In the former a square cavity is made, and it is held firmly on the ground, while the long stick is twirled rapidly to and fro in the hole. No charcoal powder is used, but a rag, or even dried leaves, are ignited. The Yánádis possess the characteristics of jungle tribes, and are little removed from savagery, the

FIG. 1.—Yánádis making Fire.

culture being that of the Palæolithic stage. This is indicated by the absence of implemental or monumental material, the animistic, and to some extent zoo-theistic, nature of the religion, the primitive hunting and fishing methods followed by many of the tribe, and the habit of eating the almost raw flesh of the game they kill, after slightly heating or scorching it. The Yánádis are fearless in catching cobras, which they draw out of their holes without any fear of their fangs. They appear to protect themselves against the effects of snake-bite by swallowing the poison sacs of snakes.

IN a paper entitled "Environment in Relation to Sex in Human Culture" in the *Popular Science Monthly* for January, Dr. Otis T. Mason gives a series of notes on the main characteristics of the chief cultural areas of America which will be useful to those who desire to obtain a general survey of aboriginal American sociology.

IN the *American Anthropologist* (n.s. vol. iii. p. 737), Dr. G. A. Dorsey describes the recent progress in anthropology at the Field-Columbian Museum in Chicago. Thanks to an energetic and efficient staff and the enlightened liberality of Chicago merchants, this museum is fast assuming a place in the

front rank of the great anthropological museums of the world. This record by Dr. Dorsey is enough to make us feel ashamed of ourselves in this country, as it is only a sample of what is being done in other American museums and institutions.

THE most interesting article to the general reader in the current number of the *Bulletins et Mémoires de la Société d'Anthropologie* (v. sér. tome 2) is one by M. C. Lejeune on the representation of sex in religion, art and education. A paper on the normal and varietal myology of the fox appears out of place in an anthropological journal. Various reproductions are given by M. E. Rivière of the mural paintings of animals from the cave of La Mouthe, similar to those to which we have recently directed attention (p. 299). It will be remembered that M. Rivière was the first to discover these paintings. A paper by M. G. Cauderlier on the causes of the depopulation of France gave rise to an interesting discussion.

IN the *Bulletin* issued by the Botanical Department at Trinidad and edited by Mr. Hart, under the heading of "Root Irritation," reference is made to the difficulty of planting out young mangosteens, cloves, or Palmyra palms. If the seeds have been started in pots, when transferred to the open ground the young plants have a strong tendency to die off. It is suggested that this may be due to the tender nature of the roots or root hairs, which seem to suffer if they are disarranged or carelessly handled in the process of transplanting. In the case of the mangosteen this question has a most important bearing, for the life of the seed is so fugitive that it becomes necessary to start the seed in pots if plants are to be forwarded to a distance; then besides the necessity for keeping the plant in good growing condition on the journey, there is the added danger of losing it when it is transplanted. Another extract from the same paper refers to the slow and irregular germination of balata seeds (*Mimusops globosa*), which may take any period from three months to two years. These seeds have a hard exterior which takes up water slowly, so that germination would probably be accelerated by piercing the seeds before sowing.

A SMALL pamphlet issued by the Indiana Agricultural Experiment Station deals with two plant pests, the horse nettle and the buffalo bur, both specimens of Solanum. The former, *Solanum Carolinense*, has travelled north from the county after which it has been named. Propagation is effected by underground shoots and also by seed. While it is easy to prevent the plant seeding, shoot propagation is not so easily checked. Ploughing cuts up the shoots, and then each portion may develop independently. Constant hoeing, however, provides a remedy, as by continual cutting the propagative power is finally exhausted; or the plant may be smothered by sowing rape or barley or other quick-growing crops. The buffalo bur, *Solanum rostratum*, has a spiny stem and fruit. It is a typical xerophyte from the south-west, from the counties of Texas and Nebraska. It seems to have been carried eastward as an impurity with other seeds. Being an annual it is more easily strangled, although it has an illicit habit of throwing up short fruiting branches if it is cut near the surface of the ground.

AMONG several interesting biological articles in the *Sitzungsberichte* of the Bohemian Scientific Society for 1901, one by Dr. J. V. Rohon on the anatomy and histology of the Devonian dermal plates and spines described as Psammosteus is of special importance. It was pointed out by Agassiz and Pander that the histological structure of these spines seemed to indicate affinity with the sharks; and Reis concluded that both Psammosteus and Pteraspis were degenerate selachians. This view is not accepted by the author, who regards both these groups of armour-clad Devonian fishes as specialised types, indicating two nearly related families. In Dr. Smith Woodward's "Catalogue of Fossil Fishes in the British Museum" the systematic position of Psammosteus was left undetermined, although some countenance was given to the theory of its selachian affinity. To the same serial Mr. J. Palacký contributes an article on the distribution of edentates and another on that of bats.

IN the *Aarbog* of the Bergen Museum for 1901, Mr. O. Nordgaard gives the results of his investigations as to the food of the coal-fish (*Gadus virens*) at different portions of its existence. From the stomachs of young individuals the author took no less than thirty distinct kinds of organisms. From this it appears that during the first year of its existence this cod subsists chiefly upon plankton. Generally this fare is sufficient, but if it fail the fish resorts to sea-weeds, where it feeds upon various minute crustaceans, young molluscs and even hydroid polyps. From the stomach of one individual were taken no less than 6250 copepod crustaceans—representing the average fauna of about 20 cubic yards of water. The stomachs of older coal-fish contained herrings, sprats, the salmonoid Mallotus, sand-eels, the cephalopod Ommatostrephes, and various crustaceans, among them Boreophausia. It is further proved that coal-fish prey on their own offspring as well as on those of the cod. In the northern fjords of Norway, where very large catches of coal-fish are sometimes made (34,000 head in the autumn of 1898), the great shoals appear to be brought together by their pursuit of herrings and Ommatostrephes. In December and January, however, a great influx of spawning coal-fish reaches the western coast of Norway.

WE have received a copy of the extremely interesting and suggestive presidential address on "The Nature of Disease," delivered by Sir T. N. Fitzgerald before Section H of the Australasian Association at Hobart in January last. After referring to the importance of sanitation, the president of the section dwelt on the evidence in favour of the hereditary nature of neurotic affections, and—in contrast to this—the comparative rarity with which deformities and malformations are inherited. In this connection he deprecated the common prejudice against the marriage of cousins, which he regarded in many respects as specially suitable. Physical diseases, other than syphilis, are also regarded as non-hereditary; and the theory of the transmissibility of many of them by infection is strongly supported. Consequently, the author of the address is greatly in favour of the isolation and notification of phthisis. In treating of the intrinsic causes of disease, emphasis was laid on the part played by bacilli, and some interesting observations are added in reference to the readiness with which the bacillary hypothesis was received by the medical profession almost as soon as it was propounded. In reference to the harm caused by alcoholism, the following sentences are worthy of quotation:—"The bicycle, I venture to say, has done more to elevate the people in the matter of temperance than a week of lectures have been able to effect. It is in this direction, then, in my opinion, that philanthropists should work. I have lived too long not to recognise 'the dullness of the lives of the masses,' and how productive of evil this lack of variety must be."

THE fifth volume of the new edition of Thompson's "Gardener's Assistant," edited by Mr. William Watson, has been published by the Gresham Publishing Company. When the sixth (and last) volume has appeared, the complete work will be reviewed.

THERE is only one opinion among men of science as to the necessity for spreading abroad the gospel of scientific truth and righteousness taught by Huxley. A sixpenny edition of a selection of his "Lectures and Essays," just published by Messrs. Macmillan and Co. in conjunction with the Rationalistic Press Association, should do much to cultivate this

desirable interest in science and philosophy. The contents include lectures on evolution and the physical basis of life, and essays on aspects of agnosticism and ecclesiasticism which may lead incipient rationalists to firm ideas "on the nature, the duties and the non-insoluble problems of human life."

A COPY of Hazell's Annual for 1902, edited by Mr. W. Palmer, was received a few days ago from the publishers, Messrs. Hazell, Watson and Viney, Ltd. The annual is so well known and widely used that little need be said as to the character of the contents. Certainly no better epitome of the subjects which attracted general attention during last year is available; and no manual can be better depended upon to give concise and accurate information concerning public men and affairs and national interests. Among the subjects of new articles in the present edition we notice anthropology, archæology, astronomy, biology, chemistry, electricity, geography, geology, meteorological office, motor vehicles, photography, telephones and universal time. Under each of these headings a short account is given of progress made during last year. These summaries are naturally of very little value to the student of science, but they serve to give general readers a view of some of the results attained. Under biology, less than a dozen subjects are mentioned—all of them zoological—and there is no reference to botany either under this heading or elsewhere in the book. Other subjects we miss are physics, metallography (to which a paragraph might well have been devoted), radiations from radium and similar substances, malaria and mosquitoes. In the list of educational associations we find the usual secondary school organisations, but not the Association of Technical Institutions, to which practically all the principals of our technical school belong.

THE overproduction of alcohol, a consequence of the overproduction of sugar, has led to many attempts to increase its use for purposes of lighting and heating. In contrast to the repressive action of our own authorities in this matter, the strangling action of which in our chemical industries is well known, M. Jean Dupuy, the French Minister of Agriculture, organised a conference in December last to discuss the best means of extending the use of denatured alcohol for lighting and heating. The current number of the *Bulletin de la Société d'Encouragement pour l'Industrie Nationale* contains a report of this conference by M. Lindet, and gives a complete account of the numerous forms of alcohol burners which have been devised both for lighting and heating. In conclusion, M. Lindet discusses the question as to the cost of heating and lighting by alcohol in comparison with the methods in current use, and especially with reference to petroleum, and points out that although petroleum has a slight advantage in the matter of cost, this is more than counterbalanced for domestic purposes by the cleanliness and freedom from smell of the alcohol.

THE same number of the *Bulletin* contains an interesting review, by M. Ach. Livache, of the methods in use for the destruction or utilisation of town refuse. The processes in use fall mostly under two types, incineration, which has been chiefly developed in this country, and treatment by reduction, in which either a solvent or superheated steam is used. The latter is mostly in favour in the United States. The relative advantages of the two methods are critically examined, it being pointed out that no hard and fast rule can be laid down which will be applicable to all cases, a careful examination and analysis of the refuse which it is proposed to treat being an indispensable preliminary.

THE additions to the Zoological Society's Gardens during the past week include a Green Monkey (*Cercopithecus callitrichus*) from West Africa, presented by Mrs. A. Clayton; a Common Otter (*Lutra vulgaris*) British, presented by Mr. W. H. Radcliffe Saunders; a Naked-footed Owlet (*Athene noctua*) European, presented by Mrs. Tewson; a Larger Hill Mynah (*Gracula intermedia*) from Northern India, presented by Miss F. V. Cooper; a Mute Swan (*Cygnus olor*) European, presented by Mr. R. S. Lindley; a South African Ground Hornbill (*Bucorvus cafer*) from Zululand, presented by Major C. H. Rowley, D.S.O.; three Lions (*Felis leo*) from South-west Africa; a Malayan Bear (*Ursus malayanus*) from Malacca; a Bennett's Cassowary (*Casuarius bennetti*) from New Britain, deposited; two Common Rheas (*Rhea americana*) from South America; a Sœmmerring's Pheasant (*Phasianus soemmerringi*) from Japan; twelve Goldeneyes (*Clangula glaucion*) European, purchased.

OUR ASTRONOMICAL COLUMN.

NEBULA AROUND NOVA PERSEI.—A circular from the Centralstelle at Kiel announces the receipt of an interesting communication from Prof. Max Wolf concerning the changes in the nebulous surroundings of Nova Persei. On March 5 he obtained a fine photograph with an exposure of four hours, which showed that all the former condensations had become weaker. From the Nova towards the south-west there now extends a new long zone of nebulosity much brighter than the previously existing condensations. Indeed on February 3, the date of the last previous photograph, this region was very bright. It is extremely interesting that this later nebulosity is brighter than the appearance of August, 1901. The same circular also announces a communication from the Lick Observatory stating that from recent photographs with the Crossley reflector Perrine finds no evidence of polarisation in condensations A and D of the Nova Persei nebula.

NEW VARIABLE STAR, 3, 1902 (MONOCEROTIS).—Prof. W. Ceraski, of Moscow, announces the variability of the star B.D. + 6°·1462,

$$\left.\begin{array}{l}\text{R.A.} = 6\text{h. } 50\text{m. } 37\text{s.}\cdot4 \\ \text{Decl.} = +6^\circ\ 21'\cdot4\end{array}\right\} (1855\cdot0).$$

The star was near maximum about February 20, being then about 7·0 mag. The determination was photographic, but there is not sufficient data yet available to calculate the period. The magnitude in the B.D. is 8·0 (*Astronomische Nachrichten*, Bd. 158, No. 3775).

SEISMOLOGY IN AUSTRIA.

AT the present time the shelves of libraries throughout the world are bending beneath volumes of statistics, the analysis of which it is hoped will lead to the discovery of something new. To these piles of undigested materials, if we surmise correctly, there is shortly to be added an inundation of statistics from those who study earthquakes. Twenty years ago, seismologists were few and far between, but now they have increased in number and are represented by organised societies, which publish journals and reports. The first of these had its origin in Japan. Fifteen years later a corresponding body appeared in Italy, following on the heels of which came commissions and committees with similar objects in various European countries. Even the time-honoured routine of many meteorological and magnetical observatories has not been allowed to rest in peace, and the daily round at these establishments includes a visit to the seismographs.

As illustrative of these new departures, we call attention to what is being done by the Royal Academy of Sciences in Vienna. In 1895 this body established a Commission for the Observation of Earthquakes, the reports of which were published in the Academy's *Transactions*. Possibly on account of their size they are now issued as separate numbers, twenty-one of which form the first series. Of the second series six parts have been issued, a brief notice of which will give an idea of the extensive and valuable investigations now being carried out in Austria.

The key to this work is found in part ii. of the series, which its author, Dr. E. v. Mojsisovics, describes as a general report of shocks recorded in Austria in the year 1900. From this

we learn that the number of earthquakes was 169 as against 190 noted in 1899 and 209 noted in 1898. To obtain these records the empire has been divided into sixteen districts, each district having its referee. Dalmatia, for example, has 423 observers, who send their observations—unfortunately for the editor—in at least three different languages, to Prof. A. Belar in Laibach.

There are five horizontal pendulum stations, four of which receive from the Government a yearly subvention of 1000 to 1100 K. A sixth station is to be installed at Pribram, one instrument to be on the surface and another at a depth of 1100 m. in the Adalbert-Schacht.

In part i. Dr. W. Láska gives a catalogue of records obtained between June 1899 and December 1900 from a three-component seismograph installed at Lemberg. From the introduction to this work it is clear that Dr. Láska has met with troubles, some of which might certainly have been avoided had he been acquainted with the experiences of his predecessors. On the second page we learn that the clock employed to drive the record-receiving photographic film has also been employed to give time marks on the same. To expect a time-piece to unroll a heavy band of paper or to turn a drum and at the same time to keep a chronometer-like rate is a false economy in which those who construct seismographs for the first time frequently indulge. Whatever inaccuracies may, in consequence of this apparent simplicity of arrangement, have crept into Dr. Láska's time determinations it was evidently his intention that what could be measured should be measured with unimpeachable exactitude. The writer has in his possession a globe which, as it could not be made in England, was purchased from abroad. Its scale is stated to be 1/25,823,716·814. Although Dr. Láska does not aim at such exactitude, he tells us that the mirror of his N.W. pendulum is 3·757 m. distant from the recording drum, whilst the period of the pendulum when hung vertically is $0^{s}\cdot31515$, to which, however, he adds that there is no certainty about the accuracy of the fourth decimal. Tables which inform us that 0·1 minute = 6 seconds, 0·2 minute = 12 seconds, &c., also convey an idea of unnecessary redundancy.

In the working of the instrument, which is installed in a cellar, a well-known bogie has been encountered. There is hardly a seismologist who has not met it, and volumes sufficiently numerous to form a moderate library have been published describing its behaviour. It is a something which causes pendulums to move fitfully, and many observers cling to the belief that it is an actual motion of the ground and either trace the same to the beating of waves on a distant shore or to some other cause. The photograms showing these movements which Dr. Láska reproduces are strikingly like those obtained from observatories all over the world. Forasmuch as a copious ventilation or the burning of a gas jet in the room thus haunted frequently results in expelling the intruders, my own opinion is that the majority of them have their origin in the movements of the atmosphere in the room rather than the movement of the ground.

To show that there may be a relationship between seismic disturbances and the movements of magnetic needles which is not mechanical, our attention is once more drawn to the ancient story of the magnet at Parc St. Maur which at the time of an earthquake was caused to move whilst a similarly formed and similarly suspended copper bar remained at rest. Our attention, however, is not drawn to the possibility that these two systems had very different natural periods of vibration.

In a supplement, suggestions are made respecting the determination of the distance of an earthquake origin from a given station from the interval which elapses at that station between the arrival of the preliminary tremors and the large waves. In recent reports issued by the British Association, especially that for 1900, it will be seen that not only have these suggestions already assumed a practical form, but also that other subjects referred to by Dr. Láska have received greater or less consideration.

Part iii. is a detailed account of earthquakes noted in German Bohemia by Dr. V. Uhlig.

In part iv. Prof. P. Franz Schwab gives the records obtained from an "Ehlert" pendulum installed at Kremsmünster. From an analysis of the records it appears that the frequency of earthquakes was much less between Apogee and Perigee than between Perigee and Apogee. In the cooler months, especially from the middle of September to the beginning of March, the pendulums were frequently unsteady. The greatest disturbances, however, accompanied marked barometric depressions. These movements probably eclipsed movements due to earthquakes.

The next number, by Dr. E. Mazelle, is a register of 146 records obtained from a Reubeur-Ehlert pendulum at Trieste.

One excellent suggestion made by Dr. Mazelle is that seismologists should have a uniform system in chronicling their observations.

The periods of his pendulums are taken monthly and are recorded to within 1/100 of a second of time, whilst a table is given to compute possible tiltings of the pendulum to within 1/1000 of a second of arc.

At the end of this paper we find certain analyses of the registers, relating, for example, to the monthly frequency and the frequency of disturbances of different amplitudes, those with amplitudes between 1 and 2 mm. forming 35 per cent. of the total observations.

The sixth part of these publications, by J. N. Woldrich, refers to the earthquake which on January 10, 1901, shook north-east Bohemia. Here and there we find reference to unusual phenomena like the swaying of forests as if moved by a strong wind, the increase or decrease of water in springs, and the effect of the movements upon men and the lower animals. The latter, excepting the story of a man who by the shaking was caused to walk in his sleep, are of the usual type.

Most of these papers are accompanied by maps or diagrams.

J. M.

SCIENTIFIC SERIAL.

THE February number of the *Journal of Botany* contains three articles dealing with mosses. The first and most interesting paper records the finding of an Arctic species, *Tetraplodon Wormskioldii*—practically a Splachnum—on Widdy Bank Fell, by Messrs. E. C. Horrell and D. A. Jones. Its usual habitat is about 70° N., and further north.—Mr. Duncan discusses the occurrence of *Octodiceras Julianum* along with Fontinalis in the River Severn.—There is the first part of a joint paper by Messrs. D. Prain and E. Baker on Indigofera species, in which it is proposed to deal with the numerous synonyms.—Mr. C. B. Clarke writes an appreciative article on Colonel Sir Henry Collett, who combined botany with various important administrative posts in India.

IN the number for March, Messrs. S. Schönland and E. G. Baker conclude a series of articles on South African species of Cotyledon.—Two sets of "Notes" deal with the distribution of plants. The first, by C. E. Salmon, enumerates floral localities in Norfolk, thereby furnishing an appendix to Trimmer's "Norfolk Flora" and the supplement thereto.—The second article, written by William Whitwell, relates to East Sussex. He alludes to the "Notes" given by Salmon in the last December number of this journal, which were more copious and referred to the whole county. These two papers, with Arnold's well-known book, should bring the Sussex flora up to date, more especially since Mr. Salmon benefited by help from Mr. Botting Hemsley and by records due to Mr. Roper.—In the supplement, Mr. Batters once again essays a catalogue of British marine Algæ, which will be very cordially welcomed. The "revised list" was published in the *Annals of Botany*, 1890, by the same writer in conjunction with Mr. Holmes. As regards localities a change will be noticed; instead of the arbitrary sections of the coast given in the revised list, specific towns, &c., are now mentioned. Practically the whole of this part deals with the Myxophyceæ, or, as they are generally termed, the Cyanophyceæ.

SOCIETIES AND ACADEMIES.

LONDON.

Physical Society, March 14.—Mr. S. Lupton, vice-president, in the chair.—A paper on the thermal expansion of porcelain was read by Mr. A. E. Tutton. The paper gives an account of experiments made to determine the expansion of Bayeux porcelain between 0° and 120° C. The material employed was a portion of the tube used by Bedford in his experiments on the expansion of porcelain between 0° and 830° C. Another piece of the same tube has also been used by Chappuis in a series of determinations by the Fizeau method between 0° and 83° C. The author has worked with an interference dilatometer, which possesses advantages over the Abbe

form of the original Fizeau apparatus. The observing part of the instrument is separated from the expansion chamber, and the temperature of the interference tripod and the substance under investigation, which it carries, is measured by means of a thermometer bent just above the cylindrical bulb and so arranged that the latter lies on the tripod table. The chief advantages over the Fizeau apparatus are briefly, (1) the employment of a micrometric method of measuring the position and width of the interference bands; (2) the use of autocollimation; (3) the employment of C hydrogen light; (4) an arrangement of the thermal chamber which readily permits an extension of the range to 120° C. The author has also introduced an aluminium compensator, a relatively thick disc of aluminium laid on the top of the porcelain tube. This overcomes the difficulty of polishing the porcelain and affords a large field of bands instead of an annular ring showing parts of bands. The mean of three determinations with three specimens of material gives the following result for the linear expansion, $L_t = L_0[1 + 10^{-9}(2522t + 7{\cdot}43t^2)]$. The results presented by the author agree tolerably well with those of Chappuis, but the constant a is slightly smaller. The constant b is seven times larger than according to Bedford. The discrepancies between the results of Chappuis and Bedford appear to be due to a fundamental real difference, dependent on the interval of temperature for which the determinations were made. The increment per degree of the coefficient of expansion of porcelain is not a constant quantity, but one which is much larger between 0° and 100° than at higher temperatures. The supposition of Prof. Callendar, as to the anomalous expansion between 0° and 100°, appears to be well founded.—The secretary then read a paper by Mr. W. Williams on the temperature variation of the electrical resistances of pure metals and allied matters. In the first part of the paper an attempt is made to correlate the periodic variations which pure metals exhibit as regards their atomic weights, chemical valencies, melting points and electric resistances. If m is the chemical valency, V the atomic volume, θ the absolute temperature, T the absolute melting point and c, or $V^{\frac{1}{3}}\alpha T$, the constant of Pictet's law, then $\sigma \propto \frac{m V\theta}{cT}$, where σ is the specific resistance at 0° C. This relation holds for most of the metals, but fails for gold, indium, tin and aluminium, and also for metals of the iron group. The temperature resistance-coefficients of pure metals are not equal to 1/273, and an expression for the change of resistance with temperature has been deduced which holds approximately for many metals. The author also obtains simple expressions for the average increment per degree of the specific heat of metals and for the ratio between the specific resistances of the solid and liquid states of a metal at the temperature of fusion.—A paper entitled "A suspected case of electrical resonance of minute metal particles for light waves; a new type of absorption," by Prof. R. W. Wood, was read by the secretary. Experiments on which the author has been engaged have led him to believe that he has found a new type of light absorption, which it may be possible to refer to the electrical resonance of small metallic particles for waves of light. Metallic deposits on glass have been produced which are shown by the microscope to consist of particles less than the wave-length of light, and which by transmitted light exhibit colours as brilliant as those produced by aniline dyes. The author has sought to explain these colours by interference and diffraction, and has been forced to accept the hypothesis suggested in the title of the paper. The metallic deposits can be obtained by heating small fragments of the alkali metals in exhausted glass bulbs, when the vapour condenses on the cold parts of the bulbs and forms the films. It can be shown that the colours are due to the presence of metallic sodium (in the case in which sodium has been used) by allowing air to enter the bulb; oxidation takes place and the film vanishes. In some experiments the air has been allowed to enter very slowly, and the changes which the film undergoes before it vanishes have been examined. The particles which form the deposits can be classed under three heads: (1) coarse particles which diffract or scatter light and give the bulb a silky lustre; (2) minute particles very close together which regularly reflect those wave-lengths absent in the transmitted light, but give no scattered light; and (3) minute particles far apart which diffuse light of the same wave-lengths as those which are to some extent absent from the transmitted light. By observing the spectrum of the transmitted light, the author has examined the changes in colour which accompany changes in temperature of the films. The paper gives an account of the relation between the colour of the film and the size and distribution of the particles, and also of the behaviour of the films with polarised light. Experiments upon the electric resistance of the films have proved that they are non-conducting. The author concludes by stating that at the present stage it is impossible to decide either in favour of, or against, the theory of resonance. The idea of resonance has proved a useful working hypothesis for explaining some of the phenomena described in the paper. The secretary read a letter from Prof. R. Threlfall directing the attention of the author to some experiments upon the same subject published by him in 1894.

Chemical Society, March 6.—Dr. E. Divers, F.R.S., vice-president, in the chair.—The slow oxidation of methane at low temperatures, by Dr. Bone and Mr. R. V. Wheeler. Much controversial matter has been published on this subject, the point in dispute being which of the two constituents of marsh gas, viz. carbon and hydrogen, undergoes oxidation first when the gas is burned in an insufficient supply of oxygen. The authors find that methane between 300° and 400° C. burns simultaneously to carbon monoxide and water, small quantities of carbon dioxide being also formed, probably as the result of a secondary reaction.—Isomeric additive compounds of dibenzyl ketone and deoxybenzoin with benzal-*p*-toluidine, *m*-nitrobenzal-aniline and benzal-*m*-nitraniline, iii., by Dr. F. E. Francis.—These additive compounds exist in three modifications, differing in melting point and other physical properties, and are thus easily separable one from another.—Mesoxalic semi-aldehyde, by Messrs. Fenton, F.R.S., and Ryffel. When tartaric acid is treated with gaseous chlorine in presence of ferrous salts it undergoes oxidation, forming the semi-aldehyde of mesoxalic acid, which can be isolated in the form of its osazone and dioxime.—The action of hydrogen peroxide on carbohydrates in presence of ferrous salts, by Messrs. Morell and Crofts. In this reaction, glucose, mannose, lævulose and arabinose are oxidised to their corresponding osones.—*m*-Nitrobenzoyl camphor, by Dr. M. O. Forster and Miss F. M. G. Micklethwait. This substance has been prepared by the action of nitric acid on benzoyl camphor. The most interesting feature exhibited by it is that it only exists in the enolic form, whilst benzoyl camphor occurs in both ketonic and enolic modifications, camphor itself being only known in the ketonic form.—The Cloëz reaction, by Dr. Chattaway and Mr. J. M. Wadmore. When cyanogen chloride or bromide reacts with sodium ethoxide, urethane and triethylcyanurate are formed. This reaction is, at first sight, inexplicable if the formula C:N.Cl be assigned to cyanogen chloride, but the authors suggest that the latter reacts first with the alcohol, forming an ethyl iminochlorocarbonate, which in secondary changes gives rise to the products mentioned above.—The picrimido-thiocarbonic esters, by Mr. J. C. Crocker. The author describes the products obtained when picryl chloride reacts with ammonium thiocyanate.—Robinin, violoquercitrin, myrticolorin and osyritrin, by Mr. A. G. Perkin. The author finds that myrticolorin, a quercetin glucoside, is identical with osyritrin.—The nitration of *sym.* trihalogen anilines, by Dr. Orton. When the aniline operated upon contains a bromine atom in the para-positions relative to the amino-group, it is replaced by a nitro-group. The similar chlorine substituted anilines do not undergo this replacement.—Some *sym.* nitrochlorobromanilines and their derivatives, by Dr. Orton. A description of the products obtained in the course of the foregoing investigations.—The resolution of pheno-α-aminoheptamethylene into its optical merides, by Prof. F. S. Kipping, F.R.S., and Mr. A. E. Hunter. This base undergoes de-racemisation when it is converted into the racemic *d*-tartrate and the latter is fractionally crystallised from water containing tartaric acid.

Linnean Society, February 20.—The Rev. T. R. R. Stebbing, F.R.S., in the chair.—On behalf of Mr. G. M. Thomson, of Dunedin, N.Z., the secretary exhibited a series of photographs of New Zealand flowers. In connection with the plants, some observations were made on the birds which visit them, *e.g.* the bell-bird or "korimako," *Anthornis melanura*, the grey warbler, *Gerygone flavirostris*, the pied fantail, *Rhipidura flabellifera*, and the yellow-breasted tit, *Petroeca macrocephala*. Of these, the first-named was observed to assist in the fertilisation of the native fuchsias, on quitting which the feathers of the head were seen to be stained with the bright

blue pollen of the flowers. A favourite nesting-site of the tit *Petroeca macrocephala*, was said to be immediately under the head of the ti-tree, *Cordyline australis*, a good photograph of which was likewise exhibited.—A paper was read by Dr. J. E. Duerden on the internal structure and histology of *Bunodeopsis globulifera*, Verrill, a West-Indian sea anemone, which he had previously described as new (in a paper on the Jamaica Actiniaria published in 1898) although without bestowing any specific name. Prof. Verrill had since described it under the name *Bunodeopsis globulifera*, but his description was limited to an account of the external characters. Dr. Duerden now described in detail the peculiarities of its anatomy and minute structure.—Mr. B. Daydon Jackson, in a report on the botanical publications of the United Kingdom as a part of the "International Catalogue of Scientific Literature," gave the history of botanic bibliography from the time of Linnæus, mentioning the admirable catalogue by Dryander of Sir Joseph Banks's library and passing on to the Royal Society's "Catalogue of Scientific Papers," at present consisting of eleven volumes, ranging from 1800–1883, the last seventeen years being in course of compilation. The genesis of the "International Catalogue of Scientific Literature" was then briefly described and the means adopted for the collection and classification of titles given. The Linnean Society had contributed the titles of papers and books issued within the United Kingdom, amounting to about 2300, and the first part of the volume devoted to botany for 1901 was now in the hands of the printers for early publication.—A paper by Miss Lettice Digby was read on her behalf by Mr. J. E. S. Moore, on the structure and affinities of some Gastropoda from Lake Tanganyika belonging to the genera Chytra and Limnotrochus, the paper being based on material which formed part of Mr. Moore's African collections. The external features, nervous system and viscera were described in detail and the affinities of the species considered.

Zoological Society, March 4.—Mr. William Bateson, F.R.S., vice-president, in the chair.—Mr. E. N. Buxton gave an account, illustrated by lantern slides, of his recent sporting-expedition to the Egyptian Soudan, in the course of which he traversed the route along the White Nile between Khartoum and Fashoda. Mr. Buxton exhibited a series of photographs of mammals and birds taken from living specimens. Among these were views of the white-eared kob (*Cobus leucotis*) and the tiang (*Damaliscus tiang*).—Dr. H. Lyster Jameson read a paper on the origin of pearls. The author's observations referred especially to *Mytilus edulis*, the common mussel. The pearls were found to be due to the presence of parasitic Distomid larvæ, which entered the subcutaneous tissues of the mussel and became surrounded with an epidermal sack similar in its characters to the outer shell-secreting epithelium of the mantle. If the Distoma died in the sack it became calcified, and formed the nucleus of a pearl, the pearl arising, like the shell itself, from the calcification of the cuticle of the epithelial cells. The parasite sometimes migrated out of the sack, in which case the nucleus of the pearl was inconspicuous. Dr. Jameson had investigated the life-history of this parasite, and found that it arose as a tailless Cercarian larva, in sporocysts, in *Tapes decussatus* and *Cardium edule*. He had succeeded in infecting mussels from Tapes in an aquarium. The adult stage of this parasite was apparently *Distoma somatinae*, Levinsen, which occurs in the intestine of the eider duck, and which the author had found in the scoter or black duck (*Œdemia nigra*). The complicated life-history of the parasite, and the absence of organs of locomotion in the Cercaria-stage, sufficed to account for the anomalous and hitherto inexplicable distribution of pearl-bearing mussels. Dr. Jameson had found that pearls were caused by similar parasites in several other species of Mollusca, including some of the pearl-oysters; and he believed that the artificial infection of the pearl-oysters could be effected in a similar manner to that which he had found successful in the case of the common mussel. When this was achieved the problem of artificially producing pearls would be solved.—Dr. P. L. Sclater enumerated the species of parrots of which specimens were contained at the present time in the Society's collection—109 in all—and made remarks on some of the rarer species.—Mr. G. T. Bethune-Baker read a paper entitled "A Revision of the Amblypodian Group of Butterflies of the Family Lycænidæ." The author was of opinion that the whole of the species of this group could be conveniently relegated to six genera—viz., Amblypodia, Iraota, Surendra, Thaduka, Mahathala and Arhopala—and that it was useless to split up the genera further, as had been attempted by some entomologists.—A communication from Mr. Martin Jacoby contained the descriptions of sixty-three new species of Coleoptera of the family Halticidæ from Central and South America.

Geological Society, February 26.—Prof. Charles Lapworth, F.R.S., president, in the chair.—On some gaps in the Lias, by Mr. Edwin A. Walford. The author's endeavour is to prove gaps in the stratigraphical succession of the Lias, involving the removal of zones or parts of zones, and also to prove palæontological gaps by the abrupt appearance of many new genera of Mollusca.—On the origin of the river-system of South Wales, and its connection with that of the Severn and Thames, by Mr. Aubrey Strahan. The southerly courses of some rivers from the Usk to the Ogmore are described, and shown to be independent of both the east-and-west folding and the north-north-westerly faulting of the rocks on which they lie. Farther west the drainage-system takes a different direction, the rivers coinciding so closely with a set of west-south-westerly disturbances as obviously to have been determined in direction by them. Of the three systems of disturbance alluded to, the east-and-west (Armorican) folding was pre-Triassic; it marks a period of compression with impulse from the south, and though it reached great intensity in Devon, Somerset and South Wales, it died away in Central Wales. The north-north-westerly (Charnian) faulting, though partly of pre-Triassic age, was renewed in post-Eocene times, and is manifested over much of the British Isles. It marked periods of relief from pressure, and of subsidence. The west-south-westerly (Caledonian) folding was the latest; it marked a period of compression, with impulse from the north, and displayed greater energy in Central than in South Wales. It gave rise to a series of subsidiary disturbances in the latter region, and initiated and controlled the river-system. The ignoring by the rivers of the structures due to the earlier disturbances is attributed to the Palæozoic areas having been overspread by Upper Cretaceous rocks at the time of the initiation of the river-system. The eastward course of the Upper Severn is attributed to the upheaval of a main axis (now the main water-parting) in Central Wales. Its deflection to the south and south-west was due to the formation of an anticline in the Chalk, which must have been parallel to, but a little west of, the present Chalk-escarpment, and which was parallel to, and contemporaneous with, the Caledonian disturbances in Wales. This anticline, acting in combination with the Armorican folding displayed in the London and Hampshire basins, initiated the systems of the Thames and Frome. Those systems were initiated in post-Oligocene and pre-Pliocene times, and the same age is inferred for the systems of South Wales and of the Severn.

MANCHESTER.

Literary and Philosophical Society, February 18.—Mr. Charles Bailey, president, in the chair.—Mr. R. L. Taylor read a paper on a modification of Rose's method of separating cobalt and nickel. In the original process described by Mr. Rose and improved by Mr. T. H. Henry, barium carbonate and chlorine (or bromine) were added to rather strongly acid dilute solutions of the two metals and allowed to stand, with frequent shaking, for from twelve to eighteen hours. The cobalt was precipitated as sesquioxide, while the nickel remained in solution. Mr. Taylor finds that if a neutral solution is used, the precipitation of the cobalt is complete in a few minutes, and that excellent quantitative results can be obtained. The retardation of the reaction which occurs when the solution is (as Rose and Henry used it) strongly acid at the outset, the author shows, is due to the free carbonic acid which is produced in the solution when the carbonate is added to the acid liquid. A similar retardation occurs in a neutral solution if carbon dioxide is first bubbled through it or if soda-water is added to it. Mr. Taylor recommends the process for the separation and detection of cobalt and nickel in the ordinary process of qualitative analysis. Either barium or calcium carbonate may be used (dry, precipitated, as usually sold, will do) with bromine water, and if no free acid is present at the outset, the cobalt is all precipitated in five minutes. On filtering, nickel can be readily detected in the filtrate by adding a little ammonia and ammonium sulphide. If there is any free acid present at the outset, it must either be boiled away or neutralised before adding the carbonate. Sodium carbonate may be used for neutralising, but then the free carbonic acid must all be boiled away, and the liquid cooled, before adding the carbonate and bromine water.—Mr.

D. L. Chapman described some experiments which have been carried out, in conjunction with Mr. F. A. Lidbury, principally for the purpose of discovering whether Faraday's law may be considered as applying to gases. The electric discharge was passed through water vapour, and the separation of oxygen and hydrogen which took place was found to be from two to three times as great as that which occurred in a voltameter placed in the same circuit. The results are, therefore, inconsistent with the view that the phenomenon is essentially electrolytic.

February 25.—Mr. C. Bailey, president, in the chair.—Dr. Henry Wilde, F.R.S., delivered the Wilde lecture, his subject being "The Evolution of the Mental Faculties in Relation to some Fundamental Principles of Motion."

DUBLIN.

Royal Irish Academy, February 24.—Prof. R. Atkinson, president, in the chair.—Prof. F. T. Trouton read for Prof. W. Ramsay, F.R.S., a paper on the molecular surface energy of some mixtures of liquids. The liquids with which the determinations were made were mixtures of carbon bisulphide and chloroform, ethylene dibromide and chlorobenzene, toluene and acetic acid, ethylene dibromide and acetic acid, ethyl alcohol and benzene, ethyl alcohol and chloroform. Mixtures in proportions varying by about 10 per cent. each step were prepared and the surface tension determined in each case at several temperatures. From these it was sought to adduce information as to the state of molecular aggregation in the mixtures by calculating the mean molecular weight in each case given by assuming that the relation $\gamma(Mv)^{\frac{2}{3}}=k\tau$ holds good for mixtures. These determinations are given in the paper in the form of tables.—Prof. John Joly, F.R.S., read a paper on solvent denudation in fresh water and sea water." The experiments are comparative: on basalt, orthoclase, obsidian and hornblende. It is found that the rate of solvent denudation unaccompanied by attrition in sea water is very much faster than in fresh water, contrary to what is generally inferred from the experiments of Daubrée.

EDINBURGH.

Royal Society, February 3.—Lord M'Laren in the chair.—Mr. James Russell read a paper on magnetic shielding in hollow iron cylinders, the magnetising force being transverse to the axis of the cylinder. The field within the cylinder was measured inductively by means of a rotating coil in connection with a ballistic galvanometer. Two different iron cylinders were experimented with, and the cylinder could, if desired, be magnetised circularly by means of a coil wound round it parallel to the generating lines. The general conclusions are as follows:—(1) When no other magnetising force is acting than that due to the transverse field increasing by increments from zero, the shielding ratio diminished by unity is proportional to the ratio permeability (B/H) and not to the differential permeability (dB/dH). In descending fields the theoretic conditions are not fulfilled. (2) When a circular magnetising force is acting upon the iron cylinder in addition to that due to the transverse field, the order and manner in which the one field is superposed upon the other affects the shielding ratio to an enormous extent, and the conclusions arrived at are not in harmony with the investigations of Stefan and Du Bois (see *Electrician*, vol. xl. p. 654, 1898). When the circular magnetisation is superposed upon a pre-existing magnetisation due to the transverse field, the shielding ratio diminished by unity is proportional to the differential permeability as impressed upon the iron by the circular field. It attains a maximum for comparatively low values of this field and then falls off towards an asymptotic minimum. When the circular field is applied first, the shielding ratio becomes distinctly reduced in value, and becomes still further reduced if the transverse field is subjected to repeated reversal. On the other hand, repeated reversal of the superposed circular field increases the shielding ratio so long as the values of dB/dH are high. The paper contained many other results of interest. Prof. Schäfer, in a note on the existence within the liver cells of channels which can be directly injected from the blood-vessels, referred to the recent work of the Drs. Fraser and Dr. Browicz, and then drew attention to the fact that in one of the slides in the possession of the physiology department of the Edinburgh University the existence of these channels was clearly indicated. The slide was prepared in 1886 for Prof. Rutherford by Dr. (now Prof.) Carlier, but though Dr. Carlier drew Prof. Rutherford's attention to it at the time, no further notice was taken of it.—Dr. D. F. Harris, in a paper on functional inertia a property of protoplasm, contended that functional or metabolic inertia is that property of living matter in virtue of which it tends to remain in the functional *status quo ante*. It is of two kinds, katabolic and anabolic, according as it is katabolism or metabolism that persists in spite of stimuli tending to alter the metabolic phase. It was shown to express itself under very different categories — biochemical as "latent period," "refractory period" (physiological insusceptibility), as rhythm, or as accompanied by consciousness. Thus functional inertia is the physiological counterpart or antithesis of irritability or affectability. Its recognition as a property of protoplasm enables us to correlate a very large number of different phenomena of both animal and vegetable life having apparently nothing else in common.—In a paper on functional inertia of plant protoplasm, Mr. R. A. Robertson gave further illustrations of Dr. Harris's views. The phenomena of latent periods in stimulation by gravity, heat, contact, injury, are expressions of the anabolic phase of the inertia; those of the periods of activity after inhibitory stimulation—as when protoplasmic movement is inhibited by high temperature, sunlight, or absence of oxygen, assimilation by cold, desiccation or darkness, growth in length by light, &c.—indicate the katabolic phase of inertia. Functional inertia finds expression in the existence of stimulatory limits, periodicity of growth and movement, and in the phenomena of polarity, and so on. It appears as a physiological insusceptibility in photochemical induction and elsewhere. In virtue of it protoplasm can be educated and new characters acquired. Its time value varies from a few seconds to hours and may be artificially extended to days; its amount may be infinite in respect of a single stimulus of any degree of intensity, but relatively small (as in the case of a dry seed) for a combination of simultaneously acting stimuli.

PARIS.

Academy of Sciences, March 10.—M. Bouquet de la Grye in the chair.—Preparation and properties of a new hydride of silicon, by MM. H. Moissan and S. Smiles. Magnesium silicide having approximately the composition $SiMg_2$ was treated with dilute hydrochloric acid, and the escaping gas, which was spontaneously inflammable and consisted largely of hydrogen, passed through a U-tube cooled down to the temperature of liquid air. A solid substance separated out in the cooled tube, which partially boiled off on allowing the temperature to rise. The volatile portion was found to be ordinary hydrogen silicide, SiH_4, the remaining liquid, which boiled at 52° C., proving to be a new compound of the composition Si_2H_6, analogous to ethane. The most remarkable property of this new compound is that of catching fire spontaneously in the presence of air at the ordinary temperature, and if a small quantity of the liquid is introduced into a large volume of hydrogen, the latter also acquires the property of becoming spontaneously inflammable in air.—The conditions of vegetation of vineyards giving high yields, by M. A. Müntz. By systematic analyses of the soil, manure added, and the amount of sugar produced in the grape, the author has been able to correlate the amounts of nitrogen, phosphoric acid and potash used in the production of one kilogram of alcohol from the fermented grapes. It is found that vines giving high yields require larger amounts of fertilising materials, but that the latter do not increase in proportion to the amounts of sugar elaborated.—On the extension of the theorem of Lagrange to viscous fluids, by M. P. Duhem.—On glycosuria due to asphyxia, by MM. R. Lépine and Boulud.—M. Winogradsky was nominated a correspondant in the section of rural economy in the place of the late M. Demontzey.—Observations of the sun made at the Observatory of Lyons with the Brunner 16 cm. equatorial during the third quarter of 1901, by M. J. Guillaume. The results are expressed in three tables, showing the number of spots, the distribution of the spots in latitude and the distribution of faculæ in latitude respectively.—A theorem on trigonometrical series, by M. H. Lebesgue.—On factorial series, by M. J. C. Kluyver.—On the cohesion of liquids, by MM. Leduc and Sacerdote. A new interpretation is given of an old experiment in which the weight required to pull away a plane glass surface from a liquid is regarded as a measure of the cohesion of the liquid. In reality the cohesion of the liquid has nothing to do with the effect.—The electromagnetic theory of the aurora borealis and the variation and perturbations of terrestrial magnetism, by M. Charles Nordmann. It has been shown that there is a close relation between the spectrum of the aurora and

that of the light round the kathode of a tube containing oxygen or nitrogen. The author concludes that the aurora borealis is a kathode phenomenon produced in the rarefied layers of the upper atmosphere by Hertzian waves emanating from the sun. The theory of Arrhenius is adversely criticised.—On a new application of optical observations to the study of diffusion, by M. J. Thovert. The optical method described in a previous paper is applied to the determination of the diffusion constants of solutions of the acids, alkalis and some salts. The numbers obtained for the salts accord well with those calculated from electrolytic data by Nernst's diffusion theory; for the acids the observed numbers are smaller than the calculated.—Remarks on a recent note of MM. Nagoaka and Honda relating to the magnetostriction of nickel steels, by M. F. Osmond.—Study of the transformations of steels by the dilatometric method, by MM. Georges Charpy and Louis Grenet. Two transformations can be observed in the iron-carbon alloys by the dilatometric method: the one brusque, produced at 700° C., with contraction of volume, corresponding to the absorption of heat observed at the critical point a_1 in the pyrometric method; the second a more gradual one, taking place at a temperature near that of the critical point a_3 as determined by the pyrometric method.—The action of hydrogen peroxide on oxide of zinc, by M. de Forcrand. The experimental results of the author lead to the conclusion that zinc can exist in three states of peroxidation, Zn_3O_5, Zn_4O_7 and ZnO_2.—On a new phosphate of soda, by M. H. Joulie. Ordinary sodium phosphate is mixed with phosphoric acid until it is neutral to litmus. On concentration, crystals of the new salt separate out; they possess the composition $Na_3H_3(PO_4)_2$. It is pointed out that this salt presents certain advantages from the therapeutic point of view.—Reduction of orthonitroazoic colouring matters: production of substituted derivatives of phenyl-pseudo-azimidobenzene, by MM. A. Rosenstiehl and E. Suais.—On the variation of rotatory power in the esters of stable lævorotatory borneol, by MM. J. Minguin and E. Grégoire de Bollemont.—On the separation of galactose and glucose by the *Saccharomyces Ludwigii*, by M. Pierre Thomas. Glucose is readily fermented by this yeast, but galactose is not attacked. Details are given of the best mode of carrying out this separation, which affords very good yields.—The study of the lactic fermentation by the observation of the electrical resistance, by MM. Lesage and Dongier.—The evolution of branchial formations in the adder, by MM. A. Prenant and G. Saint-Remy.—Study of a liver-wort with thallus inhabited by a fungus, by M. J. Beauverie.—On a fossil Parkeria, by M. B. Renault.—Researches on the modifications of the blood and serum preserved aseptically by heating. The lipolytic function of the blood, by MM. Maurice Doyon and Albert Morel.—Volume in urology. The volume type and the dynamical coefficient, by M. J. Winter.—Experimental researches on the biological life of a xiphopage, by MM. N. Vaschide and Cl. Vurpas.

GÖTTINGEN.

Royal Society of Sciences.—The *Nachrichten* (physico-mathematical section), part iii. for 1901, contains the following memoirs communicated to the Society:—

November 8, 1901:—W. Voigt: The electron-hypothesis and the theory of magnetism. A. Auwers: Right ascensions of 792 stars observed with the meridian instruments of the Göttingen Observatory in the years 1858 and 1859.

December 21, 1901:—V. Rothmund: On the formation of calcium carbide.

The accompanying "business number" contains an interesting account by the presiding secretary of the proceedings in connection with the 150th anniversary of the Society, celebrated in November last.

DIARY OF SOCIETIES.

THURSDAY, MARCH 20.

ROYAL SOCIETY, at 4.30.—Development of the Layers of the Retina in the Chick after the Formation of the Optic Cup: J. Cameron.—On a Peculiarity of the Cerebral Commissures in certain Marsupialia, not hitherto recognised as a Distinctive Feature of the Diprotodontia: Prof. G. Elliot Smith.—The Classification of the Elements: Prof. H. E. Armstrong, V.P.R.S.—Persulphuric Acids: Prof. H. E. Armstrong, V.P.R.S., and Dr. T. Martin Lowry.—On a Throw-Testing Machine for Reversals of Mean Stress: Prof. Osborne Reynolds, F.R.S., and J. H. Smith.—On the Equilibrium of Rotating Liquid Cylinders: J. H. Jeans.—A Portable Telemeter, or Range-finder: Prof. G. Forbes, F.R.S.

LINNEAN SOCIETY, at 8.—Electric Response in Ordinary Plants under Mechanical Stimulus: Prof. J. C. Bose.—On the Fruit of *Melocarina bambusoides*, Trin., an Exalbuminous Grass: Dr. O. Stapf.—On Malacostraca from the Red Sea Collected by Dr. H. O. Forbes: Messrs. Alfred O. Walker and Andrew Scott.

INSTITUTION OF ELECTRICAL ENGINEERS, at 8.—Problems of Electric Railways: J. Swinburne and W. R. Cooper.

FRIDAY, MARCH 21.

ROYAL INSTITUTION, at 9.—Recent Developments in Colouring Matters. (In English): Prof. Otto N. Witt.

INSTITUTION OF MECHANICAL ENGINEERS, at 8.—Fencing of Steam and Gas-Engines: H. D. Marshall.—Fencing or Guarding Machinery used in Textile Factories: S. R. Platt.—Protection of Lift-shafts, and Safety Devices in connection with Lift-Doors and Controlling Gear: H. C. Walker.—Guarding Machine Tools: W. H. Johnson.

EPIDEMIOLOGICAL SOCIETY, at 8.30.—Infantile Mortality in the Tropics: Dr. Daniels.

SATURDAY, MARCH 22.

ROYAL INSTITUTION, at 3.—Some Electrical Developments: Lord Rayleigh, F.R.S.

ESSEX FIELD CLUB (Essex Museum of Natural History, Stratford), at 6.30.—Annual Meeting. The Presidential Address will be delivered by Prof. Meldola, F.R.S., on The Coming of Age of the Essex Field Club, a Record of Local Scientific Work, 1880–1901.

MONDAY, MARCH 24.

INSTITUTE OF ACTUARIES, at 5.30.—The British Offices Life Tables, 1893; an Investigation of the Rates of Mortality in different Classes of the Assurance Experience, and of the resulting Net Premiums and Policy Reserves: T. G. Ackland.

TUESDAY, MARCH 25.

MINERALOGICAL SOCIETY, at 8.—The Petrology of British East Africa: Notes on the Rock-specimens collected by Prof. J. W. Gregory and Sir Harry Johnston respectively: G. T. Prior.

INSTITUTION OF CIVIL ENGINEERS, at 8.—The Greenwich Footway-Tunnel: W. C. Copperthwaite.—Subaqueous Tunnelling through the Thames Gravel, Baker Street and Waterloo Railway: A. H. Haigh.

SOCIETY OF ARTS (Colonial Section), at 4.30.—The Sphere of State Activity in Australia: The Hon. Sir John Alexander Cockburn, K.C.M.G.

WEDNESDAY, MARCH 26.

GEOLOGICAL SOCIETY, at 8.—On a Remarkable Inlier among the Jurassic Rocks of Sutherland, and its bearing on the Origin of the Breccia-Beds: Rev. J. F. Blake.—On a Deep Boring at Lyme Regis: A. J. Jukes-Browne.

CHEMICAL SOCIETY (Royal Institution Lecture Theatre), at 9.—Raoult Memorial Lecture: Prof. van 't Hoff.

CONTENTS.