THURSDAY, JANUARY 14, 1904.

EXPERIMENTAL STUDIES IN DEVELOPMENT.

Einführung in die Experimentelle Entwickelungsgeschichte. By Prof. Otto Maas. Pp. xvi+203. (Wiesbaden: J. F. Bergmann, 1903.) Price 7 marks.

ONE of the most fascinating branches of biological inquiry is that concerned with the investigation of those factors that underlie organisation and determine the course of development of the individual from the egg to its adult condition. From old time the question as to why a hen's egg should give rise to a fowl and not to a lizard or a mammal is one that has invited but never been met with a satisfactory answer, any more than the agencies have been recognised that direct and determine the orderly series of cell divisions culminating in the production of a specific form with all its marvellous organs and complex tissues.

It was formerly believed that, in some mysterious fashion, the actual structure of the adult lay concealed in the egg, much as the flowers of some of our trees can be detected in a resting condition, while it is still winter, by stripping off the bud scales that enfold them. When this view had been shown to be both logically and as a matter of experience untenable, the doctrine of epigenesis displaced it, but this, too, failed to provide a satisfactory basis on which a comprehensive explanation of the phenomena could be built up. Thus in quite recent times a revival of the evolution-theory has arisen, not, indeed, in the older and cruder form, but as promulgated by Weismann and his followers it has appeared to throw light on, and indicate a reason for, the remarkable phases passed through by the cell-nucleus during its division, and at the same time it took cognisance of the extraordinary phenomena that precede and accompany sexual reproduction. It has, however, been subjected to strenuous criticism, and weighed in the balance it, like its predecessors, has been found wanting.

The centre of gravity of current investigation is shifting again from the nucleus to the extra nuclear cell-protoplasm (cytoplasm). As the result of experiment, it has become certain that this part of the cell has to be reckoned with in any theories that pretend to group the facts together, and it is pretty certainly a good deal more than a mere nutritive substance which simply furnishes the nucleus with substances that may enable the latent possibilities of the latter to be converted into actual entities having the specific quality of form and other properties. The old definition of the cell as a mass of protoplasm containing a nucleus is still found to hold good, but the parts played by the two constituents admit of more precise delimitation than was the case even a few years ago.

A step of no small importance was made when it was discovered that by centrifugalising fertilised frogs' eggs, so as to drive the yolk up to one end of the egg, the course of segmentation becomes artificially meroblastic. Thus a condition is produced which is actually met with in many eggs (*e.g.* of molluscs) in which the yolk is present in large quantity and is unequally distributed.

Still more important was the further discovery that the first few blastomeres of a fertilised segmenting egg could be separated and induced to continue their development as isolated individuals. For this afforded an opportunity of deciding whether the organism was the product of its cells, or the cells of the organism. The results strongly point in the latter direction. The same conclusion is reached from the experiments of Hertwig, who by compression succeeded in causing the early cells of the embryo to take up abnormal positions, but the organisation of the larva did not then follow the cell-arrangement, but superseded it. The experiments with isolated blastomeres do not give the same results in all cases. Thus, if they are isolated at the first segmentation of the ovum of an Amphioxus, each gives rise to a small but perfect embryo, and thus behaves as though it were a small egg. In the sea-urchins, the isolated cells at first continue to develop as though the missing part were still present, that is, they give rise to *partial* embryos. But very soon the form of the normal embryo at the corresponding stage is made good, and small but perfect larvæ may result. Yet another example is seen in *Beroë* and some other animals, in which, whilst segmentation at first goes on as though the isolated part were a small egg, at later stages the embryo exhibits various structural defects.

It is very important to notice that these various types of behaviour do not depend on the nuclei. It might be thought that as the small larvæ, at first often defective (sea-urchins), had arisen from cells the nuclei of which had arisen by division from that of the original ovum, the defective character should be correlated directly with this fact. The nuclei might be supposed to have diverged in character, so that, for example, that of one cell contained in itself the latent potentialities of a definite half or other portion of the embryo. But such an explanation is directly contradicted by the facts as shown in Amphioxus, and would not be easily reconciled either with such cases as that of *Beroë* or by the commonly occurring modification of the further processes whereby small, but otherwise perfect, larvæ may arise in spite of the initially different mode of segmentation. Moreover, it has been shown that when freshly fertilised eggs are shaken so as to separate off portions of the cytoplasm *before* segmentation, modifications are produced very similar to those that occur in separated blastomeres. This appears to tell conclusively in favour of the great importance of the cytoplasm as a factor in determining the progress of development. In fact the egg, as has been well said, is itself an organism. Not that the parts characteristic of the adult are there present *in esse*, but the *substance*, the primordial materials out of which the early structures are severally built up, is actually present in the unsegmented egg.

There is some direct evidence available on this point. In many eggs differences of colour or texture can be seen to occupy definite positions in the egg, and if it is rotated these zones often rearrange themselves,

apparently under the influence of gravity, so as to take up the same configuration as before. This fact is highly significant in connection with the production of perfect and normal embryos, although the positions of the earlier formed blastomeres may have been so artificially shifted that their cell descendants occupy abnormal positions in the otherwise normal larva.

The correctness of this general interpretation is also supported by the readiness with which partially separated blastomeres will form double embryos. The two masses of nearly isolated cytoplasm thus develop independently, the lack of adequate contact or continuity between the corresponding parts of the two cells being apparently responsible for the monstrosity. An instructive comparison is afforded by a consideration of the results of artificially induced union of originally separate blastomeres of similar order. If these are approximated so that the axes of the different substances in each are parallel, they segment as one organism, that is, the cell division is coordinated. If, however, the axes are divergent, then each blastomere continues to segment more or less independently, and monsters of various degrees result.

These embryos, arising from isolated blastomeres of the first or following cell-generations, and also those originating from the fusion of previously isolated ones, concur in one remarkable characteristic, viz. the size of the larva at any given stage is proportionate to the relation between the cell from which the embryo actually arose, and the ovum of the species. Thus embryos from either of the first two blastomeres are half the normal size, and so on.

This variation in size is effected by a corresponding reduction in the *number* of cells that go to make up the different parts or regions of the whole, and not by a difference in their *size*. At first sight this circumstance might seem to favour the hypothesis of "unequal" nuclear divisions, *i.e.* the production of daughter cells with constantly segregating potentialities. But any such explanation is at variance both with the facts of development, taken as a whole, and with those of regeneration as well. What the evidence does seem to point to is the existence of definite substances present in the cytoplasm, and that these, though not actually representing the several organs *in parvo*, nevertheless do represent substances necessary to the formation of these organs—a very different thing. It is, then, intelligible why an organism that is left with only half the amount of any one such substance can only produce half the number of cells during cleavage; and a working hypothesis can be formed as to why regeneration is possible in some cases whilst it is apparently excluded in others. There exist strong grounds for believing that the formative stimuli leading to organogenetic development normally reside in the nucleus, but unless the substances capable of responding or of cooperating in the response to a stimulus are present, a normal result need no more be expected than that a printing machine should be capable of turning out a printed page unless the type had been inked.

But though the ground is being broken, much will have to be done before we are in a position to give a satisfactory explanation of the phenomena of development and regeneration. At present it is sufficient to analyse and investigate experimentally the agencies that are concerned in these and other vital processes; we shall thus, and only thus, be able to elevate the surviving elements of existing hypotheses to the rank of well-founded theory.

The volume by Dr. Maas will form a useful source of information for those who may desire to know what is being done in these directions. Its author does not claim to have treated the subject exhaustively, and, indeed, we could wish the sections dealing with the chemical and physical aspects of the matter had been expanded. Nor will the reader who is familiar with the work of Driesch, Roux and others perhaps find much recorded that will be new to him, but the presentation of the subject-matter is, on the whole, judicious and critical. The work covers a wider range than might be gathered from the general tenor of the present article, but as the whole subject deserves more general attention than it receives, it appeared to be more useful to attempt to indicate some of the actual results and the questions arising from them, than merely to give a discursive synopsis of a book that should be read by all who are interested in the more important biological problems of the present day.

J. B. F.

THE ALKALI AND CHLORINE INDUSTRY.

La Grande Industrie Chimique Minerale. By E. Sorel, Ancien Ingénieur des Manufactures de l'État. Pp. 679. (Paris: C. Naud, 1904.) Price 15 francs.

THIS work is concerned with the alkali industry and with those manufactures which naturally group themselves around it. That is to say, it treats of soda and potash, the chief salts of sodium and potassium, the halogens, and the principal industrial compounds of the latter, such as bleaching-powder and the chlorates.

The point of view adopted is essentially that of the manufacturing chemist or chemical engineer. Generally, however, the treatment is rather broader than this might indicate. Thus the history of a process or the growth of an industry is often outlined, and the mode of occurrence of the raw materials used is described more or less fully. As further illustrating the same point we note that, in connection with hydrochloric acid, several pages are devoted to a discussion of the effects which the acid vapours discharged from chemical works produce upon the vegetation of the locality. This, again, is followed by a chapter in which the general principles of the condensation of vapours are discussed from the thermodynamical standpoint. Nor does the author disdain to lighten his pages with occasional items of miscellaneous—not to say trivial—information. We learn, for instance, that in Central Africa "les enfants courent après un morceau de sel, comme les nôtres après un bon-bon."

The salt industry is dealt with in the opening chapter. There is a good description of the production of salt from sea-water, and some particulars of the salt deposits of Cordova, Lorraine, Stassfürt, and Transyl-

vania are included. The treatment of the mother-liquors for the recovery of potassium salts leads then to the next chapter, in which the production of potassium chloride and sulphate is described.

Here in this second chapter we have an instance, graphically told, of the kaleidoscopic changes which an unexpected discovery may sometimes bring upon a seemingly permanent industry. Balard, the discoverer of bromine, had devoted some years of his life to the creation of a new manufacture—the recovery of potassium salts from sea-water, to wit—for the benefit of his beloved Provence. The methods were worked out satisfactorily, an influential company was formed, and everything promised a great commercial success. In fact, the products were already on the market when news came of the discovery, in the "dead lands" round the little Prussian town of Stassfürt, of those great deposits of potassium and magnesium salts which have since made the district famous. Down went the price of potassium chloride to less than one-half its former figure, and with the fall vanished the new French industry. It did not, indeed, succumb without a brave little struggle, and during this the processes were so much improved that, as the author apparently thinks, a fortunate chance might even now bring them to the front again. But at that time, at any rate, the fight was hopeless, and the works round Stassfürt were speedily left victors in the markets which they have ever since controlled.

Potassium carbonate from vegetable sources is next treated of. The burning of plants for the sake of their "potashes" the author regards as a barbarous and brutal kind of industry. It appears that the march of civilisation in the United States is shown by the gradual shifting of the centres where potassium carbonate is prepared—a remark which recalls, though antithetically, the epigram about a nation's progress being measured by the sulphuric acid it requires. It is interesting to note that although at one time potash was largely displaced by soda in manufacturing processes, yet now, thanks to agricultural requirements, the demand for potassium salts is greater than ever.

Iodine and bromine form the subject of chapter iv., and are clearly if somewhat shortly described. The next twelve chapters are occupied chiefly with the soda industry. The ammonia-soda process is lucidly dealt with in two short chapters, and a considerable amount of space is devoted to the Leblanc process. The author justifies this on the ground that the latter method has still some vitality left, and is always capable of making progress. Much of the description is certainly interesting, especially that giving personal details of the discoverer, his successes, and his vicissitudes. But the interest is mainly historical. Even in this country the battle of the ammonia *versus* the Leblanc process can hardly be said to be so doubtful in its issue as the author seems to think it. The electrolytic method is barely mentioned; a little more space might well have been devoted to it.

In any adequate account of the alkali industry this country must figure largely, and such names as those of Gossage, Hargreaves, Mactear, Muspratt, and Mond receive due mention in the present work. The English Alkali Acts, too, although regarded as "Draconian," are nevertheless commended. Indeed, the author is inclined to attribute much of the progress which the alkali manufacture has made in Great Britain to the fact that the makers were forced to collect their hydrochloric acid instead of distributing it broadcast over the countryside. It is, of course, an old story, but it will bear recalling, how, in spite of the great clamour raised, the alkali manufacturers were compelled to take those steps which eventually proved to be their economic salvation. The rejected stone became the headstone of the corner; the troublesome by-product presently supported the whole industry.

Chlorine, bleaching-powder, and chlorates are dealt with in the last five chapters. There is nothing particularly new, but the descriptions include the standard processes, such as those of Deacon, Weldon, Dunlop, Mond, and Péchiney, and give a good general idea of this branch of chemical industry.

The work contains a number of illustrations, but lacks an index. It will be useful to those who require something more complete than a general text-book description, but less extensive than Lunge's standard treatise. C. SIMMONDS.

THE ELEMENTS OF ELECTRICAL ENGINEERING.

Electricity and Magnetism. By C. E. Ashford, M.A. (London: Edward Arnold, n.d.) Price 3*s.* 6*d.*

Electric and Magnetic Circuits. By Ellis H. Crapper, M.I.E.E. (London: Edward Arnold, n.d.) Price 10*s.* 6*d.*

A Text-book of Electrical Machinery. Vol. i. Electric, Magnetic and Electrostatic Circuits. By H. J. Ryan, H. H. Norris, and G. L. Hoxie. (New York: John Wiley and Sons; London: Chapman and Hall, Ltd., 1903.) Price 2.50 dollars.

THE best method of training electrical engineers will probably remain a subject of discussion so long as the profession continues to be a profitable one. Whether recourse should be had to the factory or to the technical college; whether a combination of these two is desirable or necessary, and if so, in what manner they should be combined; and whether the course at the technical college should be entirely by lecture and experiment, or should make free use of that royal road to excellence, the text-book; these and kindred questions will always be discussed and will never be settled. Whilst the discussion goes on the writers of text-books continue to flourish until the difficulty of deciding whether to have recourse to text-books or not is overshadowed by the greater difficulty of deciding which would be the most profitable to read. The three books before us illustrate how the budding electrical engineer may be caught when he is yet fresh in knickerbockers and led by easy steps to a complete mastery of his profession. Mr. Ashford's "Electricity and Magnetism" is a school-book; it starts by assuming that the pupil has no knowledge of the subject at all, and, leading him by a path of experimental inquiry, ends by leaving him well fitted to begin on Mr. Crapper's more advanced treatise. This read,

and the fundamental principles of continuous current circuits mastered, it only remains to study alternating currents in the work of Messrs. Ryan, Norris and Hoxie.

It is difficult to find anything particular to say of either of the three books, since each treats its subject in the manner which has become by now fairly familiar. They all possess certain merits not to be found in other books of a like kind, and certain defects which it is easy enough for the critic, who has only to read and not to write the book, to make much of. For example, Mr. Ashford proves Ohm's law with electromagnetic instruments, a logical mistake which it seems hopeless to eradicate from the text-book; Mr. Crapper does not prove it at all, but states that "on account of its importance as the fundamental law of electrical measurements, it may be considered in the strictest sense a law of nature," which seems to us rather a novel criterion for laws of nature. Mr. Crapper is also somewhat loose in his use of the terms force, energy, and power ("watts of energy," for example, is an expression rather difficult to understand), and, indeed, in his definitions generally —an electrolyte is defined in one place as "a compound liquid with a metallic salt in solution." These are, perhaps, slight defects, but one is justified in requiring more exactness of expression and more careful attention to detail in a text-book than one would think necessary in a lecture. The best justification that a text-book can claim is that it gives precision to the knowledge obtained experimentally in the laboratory.

Mr. Ashford's book is intended as a laboratory handbook; in our own opinion the last thing wanted in a laboratory is a handbook. Such things are never to be found for the practical experiments the electrical engineer has to make when his days of school and college are over, and the greatest benefit of the laboratory training is that it should train the student to walk alone. When experiments are so carefully described, and the results to be got and the conclusions to be drawn from them so plainly pointed out as in this book, the value of the experiment is greatly discounted, if the student even takes the trouble to carry it out properly. Mr. Crapper, on the other hand, errs by giving too much importance to the exercise class; if any student works through the enormous number of examples given in the book he will have done a great deal of arithmetic, but we doubt whether his engineering faculties will have benefited much.

Messrs. Ryan, Norris and Hoxie proceed on what is, at any rate to English readers, the somewhat novel plan of plunging forthwith into the phenomena of alternating currents, "from which the treatment of continuous current phenomena follows naturally." This seems to us rather putting the cart before the horse, as we should certainly think the understanding of alternating currents must follow, and even then with difficulty, that of continuous current phenomena. This method involves also considerable mathematical knowledge in the student, and from this point of view alone seems scarcely the most suitable to adopt.

In conclusion, we may repeat that fault-finding is easy, and that these three books have much to recommend them. They are thoroughly up-to-date, and will compare very favourably with any three other books covering the same ground which we can call to mind. Their fault is not that they are bad text-books, but that they are good text-books.

MAURICE SOLOMON.

THE PHYSIOLOGY OF MENTAL ACTIVITY.

Etudes de Psychologie physiologique et pathologique. By E. Gley. Pp. viii+335. (Paris: Félix Alcan, 1903.) Price 5 francs.

TWO-THIRDS of Prof. Gley's book are devoted to a historical and critical review of our knowledge of the physiological changes that accompany intellectual activity. The writer gives a lucid account of his own contributions to the subject in chapters upon the relation of mental work to the cardiac, respiratory, vascular, excretory, and thermogenic mechanisms. He concludes that mental work is accompanied by increased rate of heart-beat (at least in the early stages of activity), by arterial constriction and increased peripheral resistance in the extra-cerebral circulation, and by active dilatation of the arterioles of the brain. No mention is made of the experiments and views of British physiologists in regard to the much-debated presence of a vaso-motor mechanism in the brain. The author bases his affirmative conclusion merely on a study of the changes in form of the carotid pulse-curve during intellectual rest and activity. He is also inclined to believe that during intellectual activity the temperature of the brain rises slightly. Yet the evidence in favour of this view seems very far from adequate, for it has never been shown that the amount of carbonic acid evolved is increased during the activity of nervous tissue, and we are powerless to decide whether the slight rise of cerebral temperature may not be due to other causes, *e.g.* to the increased blood supply to the brain, to diminution in loss of heat from the skin arising from the already mentioned peripheral vascular constriction. To cerebral metabolism the author also attributes the increase of calcium salts in the urine during intellectual activity. This increase is said to be accompanied by more abundant excretion of urine and of magnesium salts and phosphoric acid.

Throughout the book Prof. Gley does not attempt to veil his intention to find analogies between cerebral and glandular activity, but *a priori* views, however excellent, are of little real avail in the solution of such an unusually difficult problem. There is, indeed, one complicating factor which is invariably neglected by physiologists, to which attention may be directed here. It is now generally believed that no mental process is possible without the simultaneous production of efferent impulses—in other words, thoughts must express themselves in muscular activity. Even if this maxim exaggerates the truth, there can be no doubt that, as a rule, active intellectual efforts pass over into, and to some extent manifest themselves as, muscular contractions. These contractions may appear as vaso-motor changes or as involuntary movements, and they are largely responsible, at least when

well pronounced, for changes in the general feeling or emotional tone of the individual. Now, in the first place, it is impossible to rule out changes in emotional tone altogether during any period of intellectual activity. Emotional tone is always present and always changing, obviously so where, as in several of Prof. Gley's experiments, the intellectual work consisted in reading. Secondly, even if we could maintain a constant state of feeling, we should still be ignorant how far changes in the blood-circulation accompanying purely (!) intellectual activity are due to the aforesaid tendency of ideas to realise themselves in motor activity, and how far to physiological conditions essential for the manifestation of that intellectual activity.

The three remaining chapters of this interesting book are concerned with unconscious muscular movements, the muscular sense, and abnormalities in the sexual impulse. Embodying as they do material already published by the author some eighteen years ago, they hardly call for analysis here.

C. S. M.

OUR BOOK SHELF.

L'Éducation fondée sur la Science. By C.-A. Laisant. Preface by Alfred Naquet. Pp. xlv+153. (Paris: Félix Alcan, 1904.) Price 2.50 francs.

THERE is a special interest attaching to this book since it shows convincingly that those reforms which are being urged with such conspicuous success in this country are also engaging the attention, and calling forth the proselytising zeal, of French men of science. M. Laisant does not seem to have acquainted himself with the progress of English reform in mathematical teaching. Had he studied the reports of the committees of the British Association and the Mathematical Association, and had he realised the widespread alteration in the mathematical syllabuses of our public examinations, he could not have written:—"l'éducation anglaise, par exemple, est sur certains points (et surtout en ce qui concerne la géométrie), plus pitoyable encore que la nôtre, et elle semble avoir beaucoup plus pour objet de déformer l'esprit que de développer l'intelligence, lorsqu'elle impose la récitation par cœur du texte d'Euclide" (p. 73). The suggestions made in M. Laisant's discourse "L'Initiation Mathématique" for the improvement of mathematical teaching in French schools are not only familiar to our teachers, but are, we are glad to know, widely used by them.

Similarly, if we judge from the address "L'Initiation à l'Étude des Sciences physiques," it is clear that the necessity for the employment of experimental methods in the teaching of physics and chemistry is much more widely recognised with us than in France. One may go even farther and say that our practice is in advance of the ideal which M. Laisant places before his readers. We have learnt that the only really satisfactory way for a student to learn science is himself to enter upon simple experimental research work, and by his own efforts to demonstrate the truth of chemical and physical generalisations; M. Laisant seems to imply that experimental demonstration by the teacher may suffice.

It is possible here to refer only to a few of the interesting questions raised in the other two lectures—"Éducation scientifique et Psychologie" and "Le Problème de l'Éducation." We are heartily in agreement with M. Laisant that "il est certain que les classes peu nombreuses sont une des conditions premières et essentielles d'une éducation raisonnable" (p. 97), but since this means more teachers and a correspondingly larger national expenditure, we must wait in both countries for a greater belief in education on the part of the authorities. M. Laisant considers that "l'enfant est un être raisonnable; et le but le plus essentiel de l'éducation" is "de développer en lui la faculté du raisonnement" (p. 66). This is, however, not the general experience, and Spencer's is probably the wiser view that "only after an ample fund of observations has been accumulated, should reasoning begin."

The author's remarks on the teaching of morality and religion in schools will commend themselves to most men of science, who will agree that "l'éducateur habile, en stimulant dans l'esprit de son élève le culte de la vérité, en tirant parti de tous les exemples, de toutes les observations, de l'expérience quotidienne, arrivera sans peine à façonner graduellement cette conscience d'enfant pour en faire une conscience humaine" (p. 120). A. T. S.

The Museums' Journal. Vol. ii. July, 1902, to June, 1903. (London: Dulau and Co.)

WITH the commencement of the present volume this important publication entered on a new phase of its existence, appearing in monthly parts instead of solely as an annual report. Although this change is undoubtedly for the better, it renders much of the contents of the complete volume rather ancient news, and some of the articles in the one before us have already received mention in our columns.

As regards the general condition of the Museums Association, it is satisfactory to learn that during the period covered by this report there has been a considerable increase of membership, both on the part of museums and of associates, and that this increase in the finances has been further augmented owing to the circumstance that several museums previously on the list have agreed to double their subscriptions in order to aid in defraying the increased expenditure inseparable from the monthly publication of the *Journal*.

As in the case of its predecessor, the contents of this volume cover a very wide field indeed, embracing everything connected with museums and natural history and art exhibitions, including their publications. A highly satisfactory feature is the amount of attention directed to rendering museums as interesting and instructive as possible to the general public, by whom they are maintained, and whose benefit should undoubtedly be their first aim and object. In connection with this subject we may especially refer to the article on the Haslemere Educational Museum, by Mr. E. W. Swanton, which, to judge from the appended plan, appears to be admirably designed and arranged for its purpose. In addition to general and local collections, this institution includes the almost unique feature of an aviary and a vivarium.

Whatever may be the case in this country, in America, as we learn from an article by Mr. F. C. Baker, the introduction of numerous well written descriptive labels in museums has proved a decided success. "Visitors," he writes, "have been seen to spend but a few moments examining cases installed by the old method, while a case containing some interesting material . . . will be pored over for several hours, which fact conclusively proves that the addition of carefully prepared descriptive labels is absolutely essential to the success and usefulness of a museum."

Labels in museums also form the subject of an article by Mr. F. A. Bather, who discusses certain difficulties in connection with the application of

vernacular names to specimens. Special reference is made to the case of the American bison, the author stating that no European naturalist could be prevailed upon to apply to that animal its Transatlantic title "buffalo." If, however, he will visit the mammalian gallery of the museum to which he himself belongs, he will find the label "Buffalo, in America" attached to the stand of one of the specimens of that species.

Lack of space alone precludes further reference to the contents of a volume which cannot fail to be of great value to all who have to do with museum arrangement. R. L.

Laboratory Physics. By Dayton Clarence Miller, D.Sc. Pp. xv+403; diagrams. (Boston, U.S.A., and London: Ginn and Co., 1903.) Price 8*s.* 6*d.*

THIS manual by the professor of physics in the Case School of Applied Science, Boston, is the result of twelve years of teaching experience, and most of the descriptions have been employed in type-written form for the past six years. It is not intended as a preparatory course; at the same time the majority of the experiments are of a fairly simple type. Constant references to existing text-books of practical physics (both English and American) show that the author has made free use of all sources of information, which is duly acknowledged. Many of the experiments are not usually met with in text-books, or at any rate are not met with in so full a form. Thus the complete calibration of a scale by Neumann and Thiesen's method is fully described (though without the theory, for which reference is made to Guillaume, "Thermométrie"), and there is an account of the use of Michelson's interferometer.

The author's aims are admirable. "A Laboratory course is not considered as consisting of a certain number of exercises to be worked out by each student, and to be complete when these are finished, but rather as consisting of a definite amount of time spent in judicious experimenting."

The descriptions of experimental details are good and are not overdone. The student will not be tempted to perform merely parrot work. He will require to think and scheme in many ways before his apparatus will prove tractable, and is not this just as it should be? We wish we could say that the days of organ-grinding were past.

No attempt is made to give even an outline of the *theory* of the experiments, and as the references are almost entirely to practical text-books, the student will require guidance in his choice of books from which the theory may be obtained. The manual would be improved if references to theoretic text-books were given as well.

The book is excellently printed and illustrated, and is very free from errors of all kinds. We notice only an erroneous definition of viscosity (p. 117), and the statement on p. 390 that $\pi/4=0.079577$, whereas this number is the value of the reciprocal of 4π.

Opere di Galileo Ferraris. Vol. ii. Pp. vi+473. (Milan: Ulrico Hoepli, 1903.)

THE memoirs included in the present volume may well be regarded as classical in the annals of applied electricity, since they belong to a period which has witnessed the birth and growth of the applications of electrical energy to lighting and power transmission. The first paper is an illustrated account, published in 1876, of the then "new induction machines," which, as the figures show, differed only in points of detail from the dynamo of the present day. This paper is followed by a series of five lectures on electric lighting, delivered in the spring of 1879, just about the time when, for the first time, the Piazza Colonna at Rome was brilliantly illumined by "Jablochkoff candles." The next 153 pages are occupied with a report by Prof. Ferraris on the industrial applications of the electric current, at the Paris Exhibition of 1881. In connection with that exhibition, we next have reports of the commissions appointed to deal with the determination of the ohm, atmospheric and terrestrial electricity, and the choice of photometric units. The subsequent contents comprise Prof. Ferraris's award of the prize offered in 1884 by the municipal government of Turin, reports on the Paris Exhibition of 1889 and the Chicago Congress of 1893, a discourse delivered before the Lincei Academy in 1894 on electrical transmission of energy, and an obituary notice of Gaulard, to whom as discoverer of the transformer Prof. Ferraris gives the highest praise.

Elements of the Theory of Integers. By Joseph Bowden, Ph.D. Pp. x + 258. (New York: The Macmillan Company; London: Macmillan and Co., Ltd., 1903.) Price 5*s.* net.

JUST as the names of plants and animals are constantly being altered, so the ranges of mathematical study included under such general titles as "Algebra up to the Binomial" or "Trigonometry up to Solution of Triangles" are changing as time goes on. In the "eighties," the average tripos candidate would understand by "elements of the theory of integers" the chapter in Todhunter's "Algebra" which taught him to "state and prove Fermat's theorem." The present book deals with nothing of this kind, but is devoted to proving such rules of algebra as that if $a>b$ then $b<a$, or $(-a)\times(-b)=+ab$. In the course of this work a number of cabalistic signs are introduced with which most mathematicians in this country are unfamiliar. Whether these symbols are necessary or even helpful must remain a matter of opinion, but there is no excuse for the author's incorrect spelling of the English language, as exemplified by "we hav," "ther ar," "therfor," "positiv," "canceld," "fixd," "giv."

Géographie Générale. By M. G. Lespagnol. Pp. vii+460. (Paris: Ch. Delagrave, 1903.)

THIS is an unusually comprehensive course, not of general geography as we know it in this country, but of physical geography, to which has been added a short history of geographical discovery and an essay on the growth of geographical science. The physical geography part of the volume follows the historical portions, and constitutes about three-quarters of the volume. A great deal of geological information is placed before the reader, much more than is commonly included in English books on physiography. The illustrations are numerous and generally good. There are many useful tables, and the book, as a whole, is a good introduction to an important subject. The absence of an index and a table of contents will be much regretted by students.

Pushing to the Front, or Success under Difficulties. By Orison Swett Marden. Pp. viii+416. (London: Gay and Bird, n.d.) Price 3*s.* 6*d.*

THE author's object in writing this book was "to encourage, inspire, and stimulate boys and girls who long to be somebody and do something in the world, but feel that they have no chance in life." Among the unusually large number of examples of distinguished men who have overcome successfully all sorts of difficulties, many great men of science are included, and Agassiz, Dalton, Darwin, Davy, Faraday, Franklin, Galileo, Humboldt, Huxley, and Hugh Miller may be mentioned. The book should certainly provide young men with an incentive to an increased effort to make the fullest use of their faculties and opportunities.

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.*]

Radio-active Gas in Mineral Springs.

IN a letter to NATURE of August 13, 1903, it was announced that experiments carried out at the Blythswood Laboratory had shown the presence of a radio-active constituent in the gases derived from the mineral waters of Bath. An account of our further investigations has been given in a paper read before the Royal Philosophical Society of Glasgow, November 18, 1903. Samples of water from the Buxton springs have been tested with results exactly similar in character to those given by Bath waters. In both cases the ionisation-current through the gas obtained from the water increased to a maximum in about one hour from the commencement of an experiment, and then diminished to the normal value. In a note added to this paper, December 15, 1903, an experiment is described similar to one carried out by Mr. E. P. Adams (*Phil. Mag.*, vol. vi. p. 563, 1903). A current of air was drawn through a very dilute solution of a radium salt, and then through a Winchester quart containing distilled water. The air current was continued for two hours. The distilled water after this treatment was tested in exactly the same manner as the Bath water, "the results being in all respects similar. . . . It is therefore probable that the radio-activity of these (mineral) waters is due to the presence of radium near their source."

This anticipation has been confirmed by the Hon. R. J. Strutt's discovery of radium in the iron deposits left by the hot springs of Bath.

We have recently obtained conclusive evidence of the presence of radium emanation in the Buxton springs through the kindness of Mr. J. W. Wardley, who has collected samples of the gases that rise through the water and forwarded them to us for examination. In our former experiments with water sent from the springs the amount of gas obtained was extremely small, and the consequent activity inconsiderable. We now find that the activity of the gas falls to half value in about three and a half days, the corresponding time for the radium emanation being 3·71 days (Rutherford).

It would be interesting to know whether treatment by the gases obtained from the springs possesses any therapeutic value.

BLYTHSWOOD.
H. S. ALLEN.

Blythswood Laboratory, Renfrew.

Projection of Imitation Spinthariscope Appearance.

IN thinking over how to exhibit to an audience the appearance of a zinc-sulphide screen bombarded by radium, one of my sons suggested that a kinematograph film often imitated the effect, by reason of its punctures being thrown on the screen by intermittent light. Accordingly he made a model with two numerously punctured plates mounted on eccentrics so as to slide over one another in a periodic fashion. It is sufficient, however, to hold two punctured plates by hand in the place of a lantern slide, and move them irregularly over each other slowly.

OLIVER LODGE.

American Tropical Laboratory.

THE Director of Kew presents his compliments to the Editor of NATURE and requests the publication of the enclosed letter.

Kew, January 8.

New York Botanical Garden,
Bronx Park, New York City,
December 26, 1903.

My dear Sir William,

Referring to my letter of August 14, 1903, I take pleasure in stating that the group of buildings of the Colonial Government of Jamaica at the Cinchona Botanical Garden will be maintained as a botanical laboratory by the New York Botanical Garden under an agreement with the Colonial Government, and with the cooperation of the Department of Public Gardens and Plantations of Jamaica; sufficient land for experimental purposes and for a nursery is included in the leasehold privileges. The buildings include a residence known as Bellevue House, three laboratories, two ranges of glass, and one or two small buildings suitable for lodgings.

Investigators are offered the following facilities:—

(1) The use of tables in the laboratory buildings.

(2) Lodging in Bellevue House or in one of the other buildings at Cinchona.

(3) The use of land for experimental purposes.

(4) Privileges to study the plantations at Cinchona, and also those at Hope and Castleton Gardens.

(5) Privilege to consult the botanical library of the Department of Public Gardens and Plantations at Hope Gardens, and to take books therefrom to Cinchona under such conditions as may be imposed by the Director of Public Gardens and Plantations.

(6) An immense number of indigenous species are within easy reach in the primitive forests adjacent to Cinchona.

All persons who may apply for permission to study at Cinchona must submit such evidence as the Director-in-Chief of the New York Botanical Garden may require that they are competent to pursue investigation to advantage. While in residence at Cinchona they will be under the supervision of the Hon. William Fawcett, Director of Public Gardens and Plantations, to whose interest and advice the establishment of this American tropical laboratory is largely due.

A laboratory fee, payable to the New York Botanical Garden, will be required of persons granted the above privileges.

Upon approval by the scientific directors of the New York Botanical Garden, any other institution, society or individual may be assigned the use of a table at Cinchona by the payment of one hundred dollars annually, which will entitle them to nominate students desiring to avail themselves of the facilities of the laboratory for admission without the payment of fees, but not more than one person may be granted the use of any table at the same time.

The necessary expenses for a month's residence at Cinchona, including travelling expenses to and from ports on the Atlantic seaboard of the United States, are from 140 dollars to 200 dollars; for two months' residence 160 dollars to 230 dollars.

Dr. MacDougal will be glad to give you any further information concerning this subject that you may care for, and we hope that you or some of your students may be able to utilise the resources of the laboratory from time to time.

Yours sincerely,
(Signed) N. L. BRITTON,
Director-in-Chief.

Escape of Gases from Atmospheres.

IN the Literary Supplement of the *Times* of December 25, 1903, an erroneous statement is on p. 375 placed before its readers, to the effect that our alleged knowledge of the escape of some gases from the atmospheres of planets and satellites is based on an assumed absence of helium from the earth's atmosphere, and has been disposed of by the discovery that helium is present. A brief letter was addressed to the editor of the *Times* giving proofs that the above statement is incorrect, and from this letter an extract has been published as a note in the next number of the Literary Supplement. The matter concerns one of the great cosmical agencies of nature, and I therefore request you to allow me to deal with the subject in the more adequate way which is permissible when addressing a scientific journal.

The problem of the escape of gases from atmospheres has been approached in two ways, both of which the present writer has tried, and one of them has also of recent years been attempted by other scientific men:—(1) The problem has been treated deductively by ascertaining the law of the distribution of speeds among the particles of a hypothetical kinetic system, so constructed as to be a model of gas simple enough for human mathematics to enable us to compute the distribution of speeds within it, and which it was hoped

would sufficiently represent what goes on in the actual gases with which we have to deal. This expectation, unfortunately, has not yet been fulfilled (see *Proceedings* of the American Philosophical Society, vol. xlii. p. 108). (2) The problem has been treated inductively by arguing upwards from known facts of nature. It is in reference to this second method that the *Times* makes its statement.

So far from its being true, as was supposed by the *Times*, that the argument is based on the assumption that there is no helium in our atmosphere, it is pointed out in the first memoir upon the subject that there must be just such traces of helium and hydrogen in our atmosphere as have since been detected (see *Scientific Transactions* of the Royal Dublin Society, vol. vi. pp. 308 and 309).

The facts of nature which were made the data of the investigation are four in number. The first of these is *that there is either no atmosphere or very little on the moon*, from which it is inferred that the atmosphere which the moon shared with the earth when the two bodies separated, and whatever atmospheric gases have since been evolved upon the moon, have by this time escaped. It can be shown that if this be so, then hydrogen, if uncombined, must be able to escape from the earth. There is, however, but little *free* hydrogen upon the earth, and in the atmosphere there is only the merest trace. If there is in this trace any excess over what returns to the earth in rain or in other ways, this excess is on its way upwards towards the penultimate stratum of the atmosphere, which is the part of the atmosphere from which gases escape. Accordingly, the amount of hydrogen which succeeds in getting away from the earth must be very small, while the store of hydrogen locked up in the ocean and in the solid earth is enormous. It can, moreover, be shown that there is a minute accession of hydrogen to the earth from outside, so that on the whole the quantity of hydrogen upon the earth may be almost stationary.

The second and third facts used as data are that helium and free hydrogen are being continuously supplied from the earth to its atmosphere, and that—probably in both cases, certainly in the case of helium—only a very small percentage of the gross supply is being washed down by rain or in other ways returned to the earth, notwithstanding which *neither the hydrogen nor the helium has gone on accumulating in the atmosphere*. From this it is inferred that the quantity which is present in the atmosphere has adjusted itself to be such that the outflow of these gases from the upper regions of the atmosphere balances the net supply which the atmosphere receives from below.

One other fact in nature is used as a datum—that the earth's potential of gravitation is sufficient to prevent any sensible escape of the lightest of the *abundant* constituents of its atmosphere. This lightest abundant constituent is the vapour of water.

A further paper has been published which is devoted specially to dealing with the behaviour of helium in the earth's atmosphere (see *Astrophysical Journal*, vol. xi. p. 369). In this paper it is shown from the marvellously accurate determinations made by Sir William Ramsay and his assistants that the supply of helium to the atmosphere by hot springs, and presumably the helium which oozes up elsewhere through the soil, is from 3000 to 6000 times more than can be accounted for as being a return to the atmosphere of helium which had been washed down by rain; whereas the argon, oxygen and nitrogen in such springs are all of them present in proportions which are consistent with their having been carried down by rain from the atmosphere. From which it is inferred (1) that nearly the whole of the small quantity of helium in the atmosphere is on its way outwards; (2) that helium would have become a larger constituent of the atmosphere by reason of the influx from below if there had been no simultaneous outflow from above; (3) that the rate of this outflow is presumably equal to the net rate of supply.

The escape of helium from a member of the solar system must be facilitated by the circumstances that those radiations from the sun that can affect helium have the full strength of radiation from the photosphere, inasmuch as the helium in the sun's outer atmosphere emits radiations of the same intensity as the photosphere. This is evidenced by the great helium line D_3 being as bright as the neighbouring part of the spectrum of the photosphere. We have, moreover, to take into account that outpour of corpuscles from the sun which, in the upper regions of our atmosphere, is able to excite into intense activity the internal motions of krypton which produce the green auroral line, and presumably with equal and perhaps increased vigour imparts energy to the molecules of helium which range to still greater altitudes.

G. JOHNSTONE STONEY.

30 Ledbury Road, W., January 7.

On the Origin of Spiral Nebulas.

THE ever increasing interest and importance of studies relating to celestial phenomena naturally lead up to questions which, in the present state of our knowledge, can (from the purely theoretical standpoint) in some cases be answered in a fairly satisfactory way.

The object of this note is to present certain views (some of which are believed to be new) on the probable origin of spiral nebulas, having given to start with an incandescent body like our sun.

From theory and observation we know that when different parts of the same fluid body have largely different temperatures the mass is in unstable equilibrium. The constant tendency of the resulting flow of the fluid is to equalise the temperature throughout the mass.

If the maximum temperature is in the interior of the body and the outside is exposed to a much lower temperature, the flow near the surface, through a gradual congealing of the latter, will be retarded. Such a surface will then also act as an insulator and shield to prevent both the too rapid loss of internal heat and the free escape of the accompanying gases.

The visible photosphere of the sun is known to be in a highly heated condition, and the fact that it is almost constantly being ruptured (in some zones more strongly and frequently than in others) shows—reasoning from analogy—that the solar surface has the properties of a fluid in such a state of unstable equilibrium that the superheated confined masses in the interior are still able to break through this surface at many points.

If the sun did not rotate on an axis, this surface would probably be of uniform strength throughout, for the interior circulation would then be radial. The resultant, however, of the rotary and radial forces acting on each particle produces not only an ellipsoidal figure, but also has the tendency to cause each ascending particle to move towards the equator.

As a result there is a tendency to produce surface-flow towards the equator causing an accumulation of cooled matter along the zone which but for this flow would be the weakest part of the whole rotating surface. It is therefore to be expected that two zones of least strength should exist in the solar surface, symmetrically situated with reference to the equator, but at some distance from it.

Now what is most likely to happen after a body like the sun has contracted to such a radius that the surface exists in the plastic or semi-solid state?

Such a surface will act as an insulator producing a more nearly uniform internal temperature and a consequent decrease in the interior circulation. The surface flow having ceased, and the axial velocity of rotation having increased, the zone of least surface-strength will coincide with the equator.

During the time required to reach this stage of the body's history it is probable that the lesser vents were gradually closed as the surface became stronger, resulting in periodic outbursts of increasing magnitude at a smaller number of openings until finally these also were closed.

As the *weight* of each particle of matter in the surface has increased inversely as the square of the radius (the sun's radius being unity), the internal pressure has been increased. Through the continued contraction of the outer surface this pressure, no longer relieved by periodic outbursts, increases far beyond the limit necessary to support the surface; as a result, the outer boundary grows hotter and consequently weaker, so that at last a great rupture of the surface takes place on or near the equator.

The moment this break occurs, the interior masses and

gases, which under great pressure have the properties of a fluid, move with various velocities, and along more or less curved lines toward the opening.

That component of the resulting momentum which acts at right angles to a diameter through the point of rupture causes an excess of pressure along this diameter; this excess, in the nature of a reaction, acting on a surface already strained to near the breaking point, finally causes a second rupture at the diametrically opposite part of the body.

The ejected masses will not all have the same velocity; those parts near the outer boundary of each stream will be deviated and retarded through side currents and friction at the aperture; the central parts of the stream will, in general, acquire the highest velocity, sufficient to carry the lighter matter in a radial direction far beyond the sphere of sensible attraction of the parent mass, where it finally attains a uniform velocity. The heavier masses and those near the borders of the opening will form secondary streams having various inclinations and velocities which, if there were no rotation, would be incomplete arcs of hyperbolas, parabolas and ellipses, in all of which the lighter masses would continually be outstripping the heavier ones.

Through the rotation, however, the outer parts of every stream are left behind the parts nearer the origin, so that each stream falls into a spiral curve of a more or less complicated form, resulting in an increase in the confusion of detail with diminishing distance from the centre.

If the orifices are on the equator, the radially ejected streams will be plain spirals. If the line joining the two orifices is inclined to the equator the streams will be of double curvature, each producing a spiral in the form of a helix [1] (conical). This class of nebulas not being confined to a single plane will, as a rule, exhibit much confusion of detail in projection.

In general a practically straight line drawn from the origin to any part of the plane spiral represents the actual path traversed by the matter in that particular part of the spiral, and the angular length of any given mass, measured in the direction of increasing distance from the origin, represents the corresponding arc through which the parent body rotated, in the opposite direction, while this particular mass was being cast out.

The two principal factors which operate to produce the observed form of any particular spiral are:—(1) internal pressure; (2) velocity of axial rotation.

The decrease in pressure, after the surface has been ruptured, may in some cases be so rapid that the orifices close up before the body has completed a single rotation; such a body will, later on, repeat the process, the orifices remaining open for a longer period; later still the surface will have reached such a condition that the orifices remain open for an indefinite period, finally reaching a stage represented (on a small scale) by the earth's present condition.[2]

If the earlier conditions were such that at the time of the first great eruption long ages were required for a single rotation of the body, the observed form indicates that the internal pressure remained nearly constant, and that the angular velocity was continually being accelerated. (Owing to the removal of heated matter from the interior the contraction was much more rapid than that which would have resulted from simple loss of heat at the surface.)

According to this theory, then, the spiral nebulas reveal to us the past history of the forces operating at the mouths of the two opposing volcanoes.[3] The fluctuations in the forces and in the relative amount of matter belched forth simultaneously by each crater are faithfully recorded in the often twisted, broken, serrated and irregular aspect of the masses which make up the general outline of the main hyperbolic spiral curves. This history covers the period from the first great catastrophe, represented by a distant large mass at the extreme outer limit of one branch, telling us which of the two orifices was the first to relieve the internal pressure, down to the time when the outer portions of the numerous inner streams having less initial velocity but the same angular length—or perhaps the outer portions of the main streams of a later eruption—reached to such distances from the centre as to produce too much confusion of detail for further trustworthy analysis of the form seen in projection.[1]

The generally more dense and more luminous inner boundary of the main spiral curves plainly indicates that after all these ages the lighter more swiftly moving but later ejected particles are still bombarding the earlier slower moving masses. Every time either orifice came nearly in line with, say, a particular distant previously ejected mass, the more swiftly moving particles were sent on their invisible course, many on the way transferring part of their energy of motion to other particles and to the production of the accompanying phenomena of heat and light; others to find free passage, leaving far behind those masses ejected in the same direction at previous rotations (thus crossing in radial directions the space between the main spiral arcs), finally to overtake, some to bombard the particular mass, thus helping to keep it luminous, others, like all parts of the main spiral, to continue their outward journey indefinitely, or until some other obstruction changes their energy of mass-motion into a different equivalent. Through the action of gravity the particles ejected by one body—aided by those coming from other sources—play their part to re-create the conditions leading to a repetition of the parental experiences.[2]

Isolated or heavier condensations on the spiral arcs will generally take on a cometary form indicating the direction from which the particles come. I would suggest that a long nebulous mass, as, for instance, H.V. 14 Cygni, may be a part of some great spiral (perhaps approaching and relatively near to the earth); if this is so, the general direction of the parent mass is plainly indicated in the visible structure of this nebula.

When the eruptions are periodic and of very short duration, the heavy surface-matter ejected at each re-opening of the craters will not be carried beyond the limits of the system. Certain results I have recently obtained seem to show that the masses forming star-clusters are the innermost parts of spiral structures similar to those considered in the present paper.

In the case of the great cluster in Hercules, the star-like masses are found to be connected by *nebulous streams which first leave then return towards the centre of the cluster*, showing that the initial velocity of ejection was insufficient to carry these masses (which can hardly be called stars in the ordinary meaning of the word) beyond the sphere of central attraction. A similar arrangement is found to exist among the stars near γ Cassiopeiæ. The two known nebulas near this star (first photographed by Barnard and Wolff) are but the more condensed parts of a broad spiral-like nebulous band (made up of similar condensations) which can be traced from near the middle of the second quadrant up to within a few minutes of arc of the naked eye star in the fourth quadrant. More complete details have been sent to the *Astronomical Journal* for publication.

In conclusion, it may be permitted once more to direct attention to a unique case in solar observation, bearing, as it does, directly upon the subject of the origin of spiral nebulas. How much, or rather how little, importance has been attached to this particular phenomenon, and to the "mechanical theory of comets" [3] put forward at the time,

[1] Photographs of these objects can be found in various astronomical publications. The most complete work in this line has been done by Isaac Roberts, D.Sc., F.R.S. See his "Photographs of Stars, Star Clusters and Nebulæ," vols. i. and ii.

[2] It is worthy of notice, in this connection, that the two most disturbed terrestrial regions are diametrically opposite to each other and near the equator. The deep-seated character of these disturbances is shown quite conclusively by the observed phenomena. Martinique belongs to one region, Krakatoa to the other.

[3] Spectroscopic and photometric changes in the light of certain fixed stars, when considered in connection with the phenomena which would be produced by two radially moving columns of matter (incandescent at the orifices and rotating about a fixed axis inclined at a given angle to the line of sight), might in some cases lead to more satisfactory explanations of the observed data.

[1] Through irregular variations in the pressure at the orifices, and through differences in the amount of matter ejected at different times, an endless variety of forms can be produced.

[2] Readers acquainted with Lockyer's views will notice that I adopt the theory of the meteoric constitution of nebulous matter. The evidences in favour of this theory are fully set forth in the work entitled "The Meteoritic Hypothesis," by Sir Norman Lockyer, K.C.B., F.R.S.

[3] See "Contributions from the Lick Observatory," No. 4, p. 118 *et seq.* This theory calls for just such crucial, seemingly abnormal but really typical phenomena as were presented by Borrelly's last comet.

is voiced in the language of one of the ablest descriptive writers on astronomical subjects of the present day. On p. 127 of her late admirable work entitled "Problems in Astrophysics," Miss Clerke dismisses the subject with the words, "*The only genuine 'eclipse comet' so far captured was that seen and photographed at Sohag 17th May, 1882.*" This talented writer makes not the slightest reference to the fact that the 1893 phenomenon differed in one important particular from all those it is said to resemble—that it possessed the one *observed* element which even the genuine object does not lay claim to, namely, the photographs prove that this object *moved*, receded from the sun through an angular distance equal to two-thirds of the solar diameter in less than four hours.[1] On the Mina Broncis photographs this object is plainly connected with the sun by a single, straight, isolated coronal stream.[2] J. M. SCHAEBERLE.

Ann Arbor, December 19, 1903.

Dynamical and Granular Media.

I SHOULD be very much obliged if any reader of NATURE who has studied the matter could enlighten me on the following point.

We may regard a *dynamical system* as commonly understood as being a system which, when left to itself, obeys the Hamiltonian equations

$$\frac{dx}{dt}=\frac{\partial U}{\partial \xi}, \text{ &c., } \frac{\partial \xi}{\partial t}=-\frac{\partial U}{\partial x},$$

where $x, y, \ldots$ are generalised coordinates, $\xi, \eta, \ldots$ generalised momenta, and

$$U=\tfrac{1}{2}(\xi\xi)\xi^2+(\xi\eta)\xi\eta+\ldots+V \quad \ldots\ldots (1)$$

and V, $(\xi\xi)$, $(\xi\eta)$, &c., are any functions whatever of $x, y, \ldots$

We may regard a *granular medium* as a particular kind of system coming under this heading for which U takes the form

$$U=\Sigma_r\frac{\xi_r^2+\eta_r^2+\zeta_r^2}{2m_r}+\Sigma\Sigma_{rs}F_{rs}\{[(x_r-x_s)^2+(y_r-y_s)^2+(z_r-z_s)^2]^{\frac{1}{2}}\} \quad (2)$$

where m_r stands for any constant (being the mass of the rth particle, atom, corpuscle, grain, or whatever else you like to call it) and F_{rs} is any function whatever, continuous or discontinuous, determined by the law of force between different masses.

What I want to know is this:—

(1) Is every dynamical system which can exist in Euclidean three-dimensional space transformable into a granular system according to the above definition by a proper choice of coordinates?

(2) If not, what are the precise mathematical conditions under which a dynamical system can be so transformed?

We may put these questions in a somewhat different form. It is undoubtedly possible to conceive a universe the physical phenomena of which are represented by equations of any assumed form whatever, and therefore not necessarily by the equations of dynamics. Is it possible to conceive a universe the physical phenomena of which *are* represented by dynamical equations, but cannot be accounted for by means of a granular medium? I have read many treatises and essays dealing with theories of the ether, in which it has been tacitly assumed that the only possible answer to (1) must inevitably be "yes," and I cannot but feel that a discussion in your columns might be of much use to physicists.

G. H. BRYAN.

Phosphorescence of Photographic Plates.

I OBTAINED the following results, which are new to me, in the course of some experiments on the action of light on the salts of silver.

I have not yet thoroughly examined the light or radiation emitted in these experiments, but its actinic power is low, and it appears to render the brush discharge from an induction coil more luminous.

The sensitive silver salts, such as the bromide, iodide and chloride, if precipitated and kept in the dark, have the property, under certain conditions, of emitting light in degrees proportionate to their sensitiveness. Thus the bromide, which is the most sensitive, emits more light than the iodide and chloride. A convenient way of observing the phenomenon is to take a bromide photographic plate and place it at once (*without* having exposed it) in ordinary pyro soda developing solution and allow it to remain for ten minutes. Take out of the solution, wash, extinguish the "red lamp," and in total darkness plunge it suddenly into a dish containing a saturated solution of aluminium sulphate. The plate immediately becomes phosphorescent, and the solution also is luminous, but not so bright as the plate is at first. The light gradually weakens, and in a minute or two dies away. On pouring the solution off the plate into a bottle, the whole body of the liquid becomes luminous, and has the appearance of "bottled moonlight." It remains so several minutes, and the light is increased by shaking the liquid.

If half the plate be exposed to the action of white light for a second before treating with the pyro soda solution, that half remains dark and emits no light when the plate is put into the aluminium sulphate. If the plate is given a short exposure in the camera, and developed and put into the aluminium sulphate solution, the image will appear dark on a phosphorescent background.

On placing some precipitated bromide of silver (which had been kept a few days in a corked test-tube in the dark) in a porcelain dish and exposing it to a bright red light whilst adding the pyro-soda solution, it appears black, but on pouring off the solution the precipitate gradually assumes a bright green appearance under the red light, whilst in white light it appears dark grey or black.

The remarkable part of these experiments appears to me to be the fact that the exposing of the silver salts to the action of light destroys their power of emitting it under the treatment described, whilst the salt precipitated and treated in total darkness emits light freely.

T. A. VAUGHTON.

Ley Hill House, Sutton Coldfield.

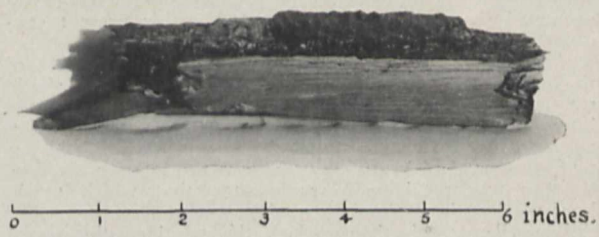
Formation of Coal

SOME of your readers will no doubt be interested to see the photograph sent herewith, which represents a peculiar growth of coal on a piece of timber.

The timber is part of a wooden trough into which, for a period of three years, water had been delivered by tanks lifting the water from a coal-mine shaft.

The formation of coal was found adhering to the vertical sides of the trough, forming a miniature coal seam about a quarter of an inch thick. This coal is hard and bright, and its texture and solidity differ in no respect from ordinary coal.

The explanation seems to be that the water contained small quantities of fine coal dust abraded from the seam



below, and these, either through the motion of the water or by some other means, were filtered out and formed anew into solid coal.

I believe this phenomenon has never previously been observed, and it appears to show that a coal seam may be broken up, washed away, and again built up in a new position without the aid of either the passage of time, pressure or heat. HENRY HALL.

Rainhill, January 3.

The Lamprey.

I SHALL feel obliged to any of your readers who will kindly tell me where to procure specimens of the lamprey. They are unobtainable at the Marine Stations of Millport and Plymouth. J. PENTLAND-SMITH.

St. Regulus, Park Place, Elie, N.B., January 5.

[1] See *Astronomical Journal*, No. 318. Also Mr. Wesley's article in *Observatory*, No. 220, p. 349.

[2] See rough sketch in "Astronomy and Astrophysics," 1894, p. 307.

EARTH STRUCTURE.[1]

IN a copiously illustrated volume Mr. T. Mellard Reade, the well-known author of the "Origin of Mountain Ranges," expounds his views on certain geomorphological changes of profound interest to geologists. By tumefaction, wrinkling and denudation, the features of the face of our world are ever changing.

Evidences of the former activity by which regions of vast extent have been elevated or depressed almost vertically are, for example, found in raised sea beaches and submerged valleys. Fossiliferous rocks high up in mountain ranges, as in the Alps and Himalayas, attained their present positions by wrinkling during the process of mountain building.

Sedimentation results in the filling up of depressions, but its weight, no matter how mobile the undercrust may be, is not, according to the author, sufficient to raise neighbouring areas. Also it must not be overlooked that the phenomena presented to us represent pulsatory movements by which large tracts have been alternately raised and lowered. Secular contraction, inasmuch as it acts in one direction, does not seem adequate to explain these regional breathings. If by this and other well-known hypotheses we fail to explain vertical elevations and depressions, Mr. Reade invites us to consider the following.

We live on a rocky crust some thirty miles in thickness which rests upon a shell of igneous magma. By the expansion or contraction of portions of this magma due to changes in its temperature, tracts of the superincumbent crust are raised or lowered. The first question we are inclined to put relates to the manner in which these assumed variations in temperature are brought about. Blanketing by deposition of sediments the author regards as insufficient, but that there are such local subterranean alterations in temperature is evidenced by the shifting of volcanic centres and the intermittent activities of the same.

Variations in the character of lavas which have issued from the same vents, but at different times, indicate chemical and mechanical changes in a subjacent magma, and with such changes heat may be evolved or absorbed, and a magma may increase or decrease in its volume. Attention is also directed to the remarkable chemical and mineralogical alterations and the accompanying volumetric changes which have taken place in rock masses. With the phenomena of recalescence and magnetisation, alterations in bulk take place. In short, "the earth is not an inert mass cooling in space," but it is a planet within which there is flux and reflux, action and reaction, mechanical, chemical, and other activities in operation which result in the evolution of heat and alterations in volume, and in the latter we are to look for the cause of vertical elevations and depressions. References to the effect of these displacements in altering the level of oceanic water are made. The swelling or contraction of a magma beneath an ocean bed must result in a general rise or fall of water on the land.

The second form of geomorphic change considered is that which is due to a tangential creep and ridging of sediments due to fluctuating increases in temperature, and consequent expansion brought about by sedimentation. The wrinkles or mountain ranges on the face of the world are the results of such changes. With a falling temperature contraction sets in, strata shorten, and tensions result in faulting. By the faulting, wedge-shaped blocks fall inwards to act like keystones for the material on their flanks. The old theory that the features of the world are largely due to a shell accommodating itself to a retreating nucleus also accounts for the formation of the wrinkles by compression, but, unlike the theory advocated by Mr. Reade, it does not provide an explanation for normal faults which partition the roof of the world into block-like masses. That continental outlines are due to subsidences of the neighbouring oceanic basins, and are therefore sketched out by fault lines, is, according to the author, very doubtful; at all events, evidences of such dislocations, we are told, remain to be discovered. His own view is that for the most part such outlines are defined by mountain ranges, which represent thick accumulations of detritus derived from the denudation of land areas, lifted up by expansion on the platforms where they were deposited.

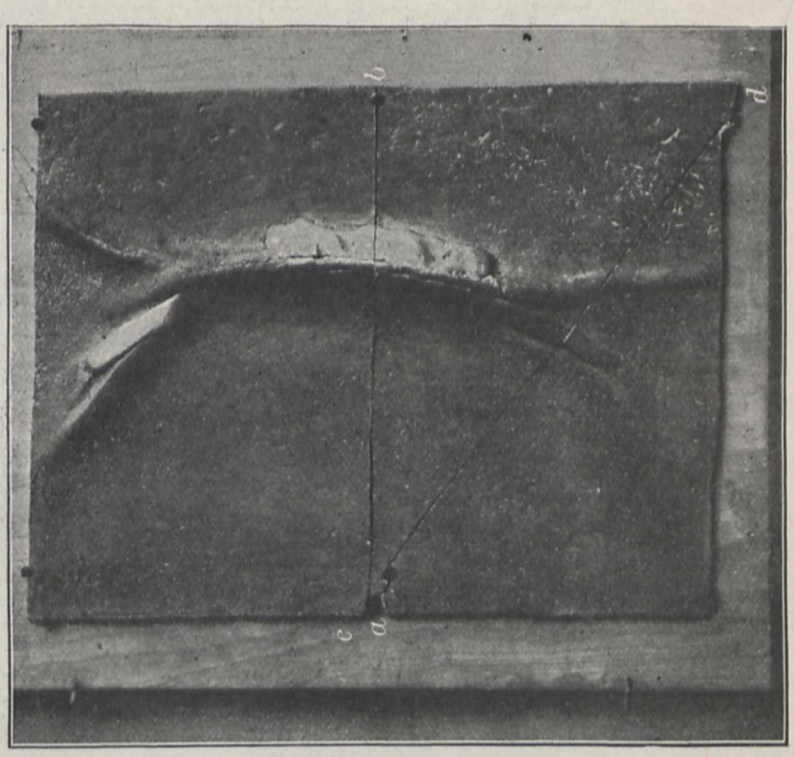


FIG. 1.—Showing cumulative effects of changes produced by hot and cold water upon a lead plate forming the lining of a pantry sink. A section along *a*, *b*, is shown in Fig. 2. (From "The Evolution of Earth Structure.")

A large section of the work refers to observations and experiments which throw light upon the foregoing hypotheses. The effects of end pressures as applied to layers of sheet lead, bars of soap, damp sand, and other materials are already fairly well known. An anticlinal rises near to the source of pressure, but the foldings are not altogether in accordance with those observed in nature. The effects of thrust are not con-

[1] "The Evolution of Earth Structure, with a Theory of Geomorphic Changes." By T. Mellard Reade. Pp. xv+342. (London: Longmans and Co., 1903.) Price 21s. net.

veyed to a sufficient distance, and Mr. Reade points out that, with similarly applied forces, something similar should occur in the earth's crust.

Results more in accordance with structures noted by the geologists are, however, seen in the effects of pressure originating in the general expansion of stratified material.

An observation bearing upon this form of action, which extended over many years, refers to the cumulative effects of changes produced by hot and cold water upon a lead plate forming the lining of a pantry sink. First it ridged up to form an overfold and eventually cracked. The fold was cut out, bent down, and soldered. In eight years' time the fold had again grown, little by little, by material imperceptibly flowing to the site of the fold, until it resembled the model of a mountain range.

The crescentic form of this ridge is seen in Fig. 1, the centre of the discs, but one on the right and the other on the left of a diameter. By placing cores upon the bed plate, or by deforming the bottom disc of clay upon which the other discs are placed, centripetal pressure results in anticlinals, spiral folding, various forms of shearing, and other structures, each being dependent upon the bias given by the form of the core, and it is to multilateral pressures akin to those employed in his experiments that the author ascribes many of the forms met with in mountain ranges.

Other interesting chapters relate to the effects of expansion due to atmospheric changes in temperature as exhibited by asphalt, cement, rails, and other substances, the production of slaty cleavage, and the supposed permanence of oceanic basins and continental domes.

The effects of denudation as a factor playing an important part in shaping the features of the world are

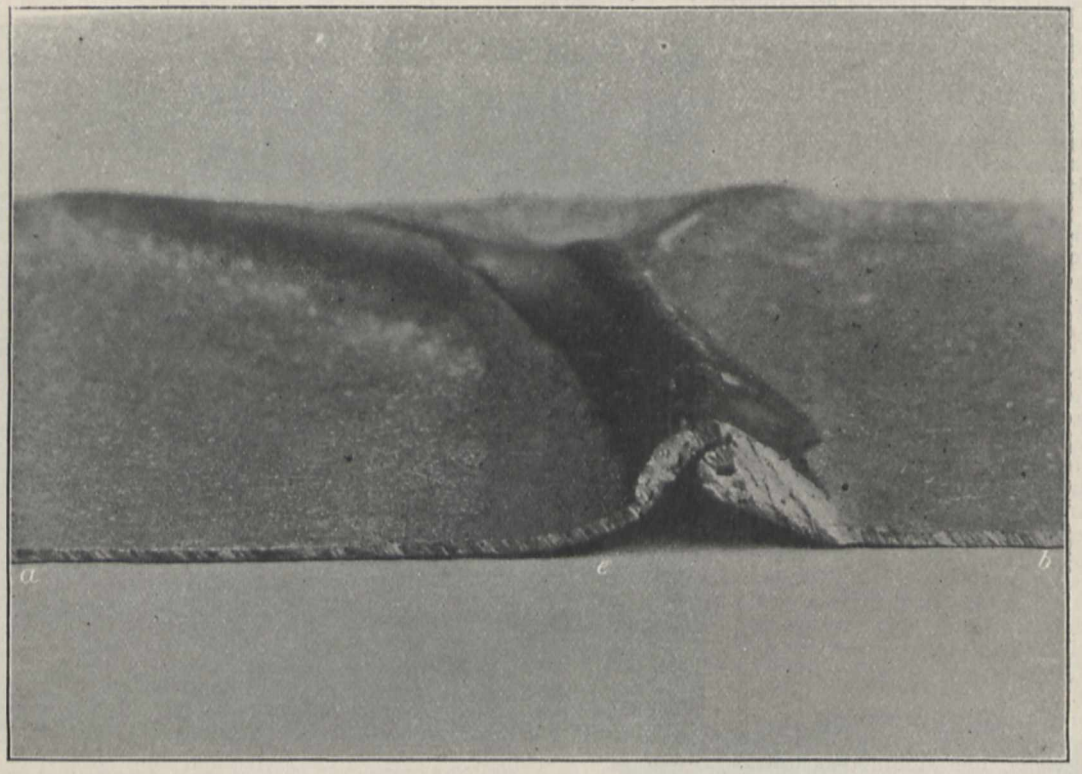


FIG. 2.—Photograph of section along saw-cut line *a*, *b*, Fig. 1, showing structure of the fold and overfold. (From "The Evolution of Earth Structure.")

whilst a section of the same through *a*, *b* (Fig. 2) shows that it had become an overfold. It is a form that could not be produced by external pressures, and as it so closely accords with the theory it is intended to illustrate, it well deserves the space, which is that of a whole chapter, devoted to its history.

Torsional structures, as, for example, those noted in the dolomites, and the curved axes of mountain ranges met with in nature, may be explained by multilateral or circumferential pressure, particularly when it is assumed that an initial bias is given by the form of the floor on which the strata have been deposited.

Experimental demonstrations of the effects of this form of pressure were made by compressing discs of clay confined by a circular metal loop, the diameter of which could be altered, much in the same manner that the diameter of a loop in a piece of string may be altered by pulling on the two ends. The ordinary effect of converging pressure is to produce doming, not in hardly mentioned, the reason being that they have already received so much attention from other writers. Mr. Reade deals almost entirely with activities which are hypogenic, and these, although some of them may be old acquaintances, he presents to geologists in a manner so novel that they acquire an importance which most certainly they did not previously possess. The ancient contraction theory is to be largely supplanted by one of expansion and contraction.

The amount of vertical movement asked for may be taken at 10,000 feet, or 1/2000 of the earth's radius —to human beings a quantity that is stupendous, but when regarded as a deviation in the smoothness of our globe it becomes a quantity that is insignificantly small. The author will no doubt find many followers; some may hesitate, but even those who have crystallised an ancient faith will pause to think and give to originality the consideration it deserves.

J. MILNE.

THE SANTA CRUZ FAUNA AND THE PRINCETON EXPEDITION TO PATAGONIA.[1]

IT is with the greatest satisfaction that we welcome the first-named instalment of an important work. The Santa Cruz Tertiary mammalian fauna is one of the most interesting and remarkable in the world, and we have now, for the first time, a guarantee that it will be described in a manner worthy of its importance. Hitherto this wonderful fauna has been but very scantily represented in museums outside of the Argentine, and in consequence students could gain only a very imperfect idea of its extent and affinities owing to the majority of the descriptions being of a more or less preliminary nature and inadequately illustrated. The acquisition by the Princeton Museum of the very large series of specimens collected by the expeditions to Patagonia under the charge of Mr. J. B. Hatcher from 1896–1899, together with a careful survey of all the other known collections, has now rendered it possible to publish full and adequate descriptions of all the more important types, and through the liberality of Mr. J. Pierpont Morgan the work will not be cramped for lack of illustrations.

In the introductory chapter, Prof. Scott, whose name is a sufficient guarantee for the excellence of the work, states that it has been decided to describe the specimens with a degree of detail which would be unnecessary in the case of forms well represented in museums throughout the world, and this detail will render his treatment of the work practically exhaustive. Some idea of the magnitude of the task will be gathered when we state that the present fasciculus of 106 4to pages is devoted entirely to the armadillos.

From the general character of the Santa Cruz fauna Prof. Scott is of opinion that Miocene Patagonia was rather an outpost of the South American fauna than the main area of its development. So far as the Edentates are concerned, this statement is justified by the apparent absence from the Santa Cruz horizon of representatives of the true sloths and anteaters, which, judging from the comparatively slight differences between the Santa Cruz Edentates and their Pampean successors, must almost certainly have been in existence at the epoch in question. This view is strengthened by the circumstance that many of the modern types of armadillos are unrepresented by ancestral forms in the Santa Cruz formation.

In general the Santa Cruz armadillos may be said to have attained the modern degree of specialisation, although in many details primitive features are retained. None of them, for instance, have an anterior solid shield to the carapace, which consists in most cases entirely of movable bands, although in certain instances a pelvic shield is developed. The most aberrant type is the horned Peltephilus, which has a full series of front teeth. The reference to this genus of a humerus of a somewhat monotreme-like type is not supported by the Princeton collection. Following the lead of other American zoologists, Prof. Scott splits up the Edentata into a larger number of family and generic groups than has generally been the fashion in this country, the number of such divisions being, of course, largely a matter of individual opinion. Prof. Scott, it will be noticed, has no hesitation in regarding the Santa Cruz fauna as of Miocene rather than of Eocene age.

The collection and description of the fossil mammals and birds, although the prime, was by no means the sole object of the expedition, and, according to a provisional scheme issued by the publication committee, it is intended to issue a full account of the zoology, palæontology, botany, and geology of the districts traversed. In this scheme it was proposed to complete the work in six volumes of about 500 pages each, and to do this within a period of four years. Apparently, however, this scheme proved inadequate, for in place of the botany forming a portion of vol. i., we find the sections before us constituting the first part of an eighth volume, the whole of the first being devoted to the narrative of the expedition and geography.

With regard to the botany, a very brief notice must suffice. The general characters of the vegetation of western Patagonia are described by Prof. Dusèn, who directs attention to the sharp demarcation between the evergreen and the deciduous beech-forests respectively characterising the two slopes of the Cordillera, and also between the whole forest tract and the Patagonian steppe. The Bryophyta are described by the same writer, but the Hepaticæ are treated by Mr. Evans and the Pteridophyta by Mr. Macloskie.

The bulky and beautifully illustrated volume devoted to the narrative of the expedition and geography teems with interest, but here, again, limitations of space prevent our doing justice to its contents. Perhaps the most generally interesting section is the one describing the Tehuelche Indians and their mode of life, which contains a number of most excellent portraits of these interesting tribes, as well as illustrations of the manner in which guanaco robes and other articles are manufactured. Judging from plate l., the Tehuelche girls are far from uncomely, but, as shown in the preceding plate, there is a sad falling off in personal appearance with advancing age.

So far as it is yet advanced, the work is an excellent example of the thoroughness of modern American treatment of scientific subjects R. L.

[1] "Mammalia of the Santa Cruz Beds—1. Edentata, Dasypoda." By W. B. Scott. Rep. Princeton Exped. to Patagonia v., pp. 1–106; plates i–xvi. "Botany," part i. By P. Dusèn, A. W. Evans and G. Macloskie. *Ibid.*, viii., pp. 1–138, plates i.–xi. "Narrative of the Expeditions and Geography of Southern Patagonia." By J. B. Hatcher. *Ibid.*, i., pp. 314, illustrated.

PROF. KARL ALFRED VON ZITTEL.

GEOLOGISTS and biologists throughout the world will lament the death of Prof. K. A. von Zittel, the accomplished palæontologist of Munich. For more than thirty years he had been acknowledged as the leading exponent of the science which is intimately connected with the progress both of geology and biology. For a still longer period his charming personality had combined with his wide reputation to attract to the Palæontological Museum at Munich students of the natural sciences from all civilised nations. Those who were unable to follow the prescribed university course were at least frequent guests, taking advantage of the unrivalled facilities for study and research among fossils which the professor's laboratories and collections afforded. So highly appreciated, indeed, was the school of palæontology in Munich that Prof. von Zittel soon began to experience the practical sympathy of several of his wealthy fellow-citizens, who had learned of his fame. In this manner he was provided with funds to equip expeditions and purchase collections of fossils beyond the means of most institutions of a similar character. The result was that the Palæontological Museum in the old Academy of Munich, already fine when von Zittel became professor, rose to preeminence among the museums of the European continent. It began to illustrate not only Bavaria and Europe, but every part of the world from which fossils were known; and as the collections were acquired, descriptions of all the important novelties were always quickly published, usually prepared by some student-graduate working under the professor's direction.

Prof. von Zittel had the advantage of beginning his great life-work at the early age of twenty-seven. Born at Bahlingen, in Baden, on September 25, 1839, he completed his education in the Universities of Heidelberg, Paris, and Vienna, and in 1863 he became teacher of geology and mineralogy in the polytechnic at Carlsruhe. In 1866 he succeeded Oppel as professor of geology and palæontology in the University of Munich. At this time he was interested in questions of stratigraphical geology, which depended much on the accurate determination and comparison of fossils. He had already written two important memoirs on the bivalved shells from the Cretaceous Gosau formation, which had been published by the Vienna Academy. He was then beginning to study the so-called Tithonian formation, on which he issued an important memoir in 1870, determining that it was equivalent to the Purbeck and Wealden formations of western Europe. These and other researches of a similar nature gradually impressed upon von Zittel the necessity for a fundamental revision of the whole science of palæontology, as it was then understood, and the preparation of a comprehensive treatise on the subject which could be used as a work of reference. He accordingly planned his now famous "Handbuch der Palæontologie," which was begun in 1876 and completed in four volumes in 1893, and this was the systematic basis of nearly all his future research. He thoroughly studied the fossil representatives of each group of the animal kingdom in order from the Protozoa to the Mammalia, and his original observations were not only incorporated in the "Handbuch" itself, but also formed the subject of many special papers and memoirs. Quite at the beginning of his task he met with unusual difficulties in the classification of the sponges, which necessitated his abandoning the projected treatise until he had devoted three years to his classical "Studien über fossile Spongien," which were published by the Royal Bavarian Academy between 1877 and 1879. Almost simultaneously with the early work of Sollas in the same direction, von Zittel devised a means of studying the fossil sponges in thin sections under the microscope, and his novel researches eventually led to a systematic arrangement of the Porifera, which has been confirmed in all its essential features by subsequent investigations of both extinct and living forms. Some of his memoirs related even to the Vertebrata, and those on the Chelonia and Pterodactyls from the Lithographic Stone of Bavaria (*Palaeontographica*, 1877, 1882) are especially valuable contributions to science.

On occasional excursions Prof. von Zittel still devoted himself to purely geological work, and among his published observations may be particularly mentioned those on the glaciation of the plain between Munich and the Alps, made in 1874 and 1875. Only in one instance, however, did he undertake researches of a geological nature on a large scale, namely, when he accompanied the Rohlfs Expedition to the Libyan Desert in 1873–74. The important results of these investigations were presented to the Royal Bavarian Academy as a "Festrede" on March 20, 1880, and a more detailed report (reprinted from the *Palaeontographica*) was issued as a separate work in 1883 under the title "Beiträge zur Geologie und Palæontologie der Libyschen Wüste." In this volume von Zittel's geological treatise was supplemented by a series of detailed descriptions of the fossils by Fuchs, Mayer-Eymar, Schenk, and other palæontologists.

The *Palaeontographica*, to which reference has been made, is a serial devoted solely to illustrated memoirs on fossils, founded by the eminent German palæontologists W. Dunker and Hermann von Meyer in 1846. From 1869 until his death Prof. von Zittel was its responsible editor. The Munich school was thus provided with ample means for publishing palæontological researches, and the editor's former pupils have for many years been the principal contributors to its pages. Although Prof. von Zittel himself was the main factor in the production of many of these memoirs, he always regarded his share as merely that of a helpful teacher, and did not overshadow the plodding student by adding his own name as joint author.

For the purposes of elementary or less specialised teaching the professor published a large and valuable series of lecture-diagrams of palæontology ("Palæontologische Wandtafeln," 1879–91), and as soon as his great "Handbuch" was finished he began at once to prepare an up-to-date epitome of it in one volume, which appeared in 1895 as the "Grundzüge der Palæontologie." Von Zittel also sometimes attempted more popular writings, such as his little readable volume on rocks and fossils, named "Aus der Urzeit," which appeared in 1872, with a second edition in 1875. This work contained some interesting maps of the distribution of land and sea in Europe during the various Mesozoic and Tertiary periods. His last essay of general interest was an address on "Palæontology and the Biogenetic Law," read before the International Congress of Geologists in 1894 and published in English in *Natural Science*, May, 1895.

The address just mentioned was almost the only occasion on which Prof. von Zittel ventured to express any opinions on the philosophy of biology or the solution of fundamental problems. Apart from his brilliant researches on sponges, indeed, scarcely any of his work can be regarded as suggesting important novel points of view. His "Handbuch" contains innumerable new facts obtained by personal observation, and they are accompanied by many proposed changes in classification or nomenclature, but only a small proportion of these emendations have proved acceptable to those who have pursued later research. His comprehensive treatment of palæontology has stimulated the progress of the science and has been of immense value, not because it suggests problems, but because it is a monument of judicious industry and thoroughness in the collection and presentation of the known facts. Von Zittel's "Handbuch" is indeed a trustworthy dictionary for reference rather than a guide to profitable lines of inquiry; and when the Americans, under the direction of Dr. C. R. Eastman, attempted a few years ago to infuse more philosophy into an English edition of the section Invertebrata of his "Grundzüge," Prof. von Zittel did not hesitate to express his dissent in conversation. A second edition of the first part of the "Grundzüge" has just appeared, in which none of the American palæontologists' changes are admitted. To understand the author's position it is only necessary to quote a sentence from his address of 1894:—"An important part is played to-day by subjective opinions, and when I think of the anxiety with which we elders—we who received our scientific education before the Darwinian era—proceeded to found a new species or genus, and compare it with the light-hearted manner in which to-day species, genera, families, and orders are set up and again put down, I am herein most forcibly impressed by the difference between then and now. The domination of the Linnæan and Cuvierian principles threatened systematic biology with soulless paralysis: the unbridled subjectivity of recent times may easily lead to anarchy."

A very striking instance of Prof. von Zittel's tireless industry in judicious compilation is his valuable "Geschichte der Geologie und Palæontologie bis dem Ende des 19ten Jahrhunderts," published by the Royal

Bavarian Academy in 1899. This volume was translated into English by the author's distinguished pupil, Mrs. Maria Ogilvie-Gordon, and issued in a slightly abbreviated form in Mr. Walter Scott's Contemporary Science Series in 1901. It will always remain a standard work of reference.

Prof. von Zittel naturally received numerous honours. Many years ago he became a Privy Councillor, and from 1899 until his death he was president of the Royal Bavarian Academy of Sciences. He was elected a foreign member of the Geological Society of London in 1889, and received the Wollaston medal in 1894. He was made a foreign associate of the United States National Academy of Sciences in 1898, and a correspondant of the Paris Academy of Sciences in 1900. His greatest joy was the ardent friendship with which he was honoured by his former pupils scattered through nearly all the civilised nations of the globe.

A. S. W.

NOTES.

THE fifth International Congress of Zoology, held at Berlin in 1901, selected Switzerland as the place of meeting for the sixth session, and elected Prof. T. Studer president. In accordance with this resolution, the congress will meet at Bern from August 14–19 of this year. Prof. Studer, Bern, is president of the general committee, and the vice-presidents are:—Prof. E. Beraneck, Neuchâtel; Prof. H. Blanc, Lausanne; Dr. V. Fatio, Geneva; Prof. L. Kathariner, Fribourg; Prof. A. Lang, Zürich; Prof. E. Yung, Geneva; Prof. F. Zschokke, Basel; and Prof. R. Blanchard, Paris. The secretaries are Prof. M. Bedot, Geneva; Dr. J. Carl, Geneva; and Dr. W. Volz, Bern. The general meetings will be held in the Palace of Parliament at Bern, and the sectional sittings in the new university. During the congress there will be an excursion to Neuchâtel and to the Jura lakes, in order to visit the lake-dwellers' settlements. The closing meeting of the congress will be held at Interlaken. Afterwards the members of the congress will be invited to visit other Swiss cities. Communications or inquiries referring to the congress should be addressed to the president of the Sixth International Congress of Zoology, Museum of Natural History, Waisenhansstrasse, Bern. The congress is open to all zoologists and to all who are interested in zoology.

THE *Atti* of the Lincei Academy announces the death, on November 25, of Angelo Maffucci, a member of the Academy since July, 1900.

A NEW Pasteur Institute has, says the *British Medical Journal*, been established at New Orleans, where the antirabic treatment will be carried out without any expense to the patients.

IT is announced that Dr. Felix Kanitz died at Vienna on January 5. Dr. Kanitz, who was born at Budapest in 1829, was well known for his archæological and ethnographical labours in the Balkan peninsula.

IT is reported that the Goodwin Sands lightships are to be put in communication with the shore by means of wireless telegraphy, and that the installation is to be completed in about a month. Four lightships will communicate with the Admiralty wireless telegraphy station near Shakespeare Cliff, Dover.

LIEUT. E. H. SHACKLETON, late third lieutenant of the *Discovery*, and one of the three men who reached furthest south in a journey from the ship, has been appointed secretary of the Royal Scottish Geographical Society in succession to Lieut.-Colonel F. Bailey. Lieut. Shackleton had to be invalided home from the Antarctic on account of hæmorrhage of the lungs.

THE death is announced of Dr. F. von Hefner-Alteneck, a member of the Berlin Academy of Sciences and a well-known engineer. Dr. von Hefner-Alteneck was born at Aschaffenburg in 1845. After studying at Munich and Zurich he entered the firm of Siemens and Halske, with whom he remained until 1890. He became chief engineer of the firm, and was the inventor of many electric appliances produced by that house.

THE Geological Society of London has this year awarded its medals and funds as follows:—the Wollaston medal to Prof. Albert Heim, of Zurich; the Murchison medal to Prof. G. A. Lebour; the Lyell medal to Prof. A. G. Nathorst, of Stockholm; the Wollaston fund to Miss E. M. R. Wood; the Murchison fund to Dr. A. Hutchinson; the Lyell fund to Prof. S. H. Reynolds and Dr. C. A. Matley; the Barlow-Jameson fund to Mr. H. J. L. Beadnell.

BARON ERLAND NORDENSKJÖLD, who left Southampton on January 6 on an expedition to Bolivia, informed a representative of Reuter's Agency that the expedition would last at least eighteen months, as he intended to penetrate the northern forests of Bolivia for the purpose of studying the hostile Indian tribes along the various tributaries of the Amazon, and the region to be traversed was practically unknown. He is accompanied by Lieut. D. de Bildt, a son of the Swedish Minister in London, and Dr. Holmgren.

AT a meeting on January 5, the Bath City Council had under consideration a letter from the National Trust relative to the quarrying in the Cheddar Cliffs, and unanimously adopted the following resolution:—"That this council has heard with sincere regret of the damage which is being caused to the Cheddar Cliffs by the quarrying of stone therefrom, and other works connected with such quarrying, and trusts that steps may promptly be taken for preserving in its original condition, so far as practicable, this most picturesque and interesting feature of the West of England." Similar resolutions have also been passed by the Somerset County Council and other public bodies in the district.

DR. NORDENSKJÖLD and the members of his South Polar Expedition arrived at Hamburg on January 6. The unexpectedly early return from the South Polar regions of this expedition has, the *Times* states, enabled Dr. Jean Charcot to recast the plans of the French expedition on board the *Français*. He now proposes to explore the west coast of Graham Land and to carry out a very exhaustive scientific investigation of that region. From Flanders Bay, at the south-west end of Belgica Strait, Dr. Charcot intends to push south in the direction of Pitt Island and Adelaide Island, with Alexander Land as the great goal of the expedition's efforts. With the return of the Antarctic spring, if winter quarters have been taken up far enough south, Alexander Land will be the objective of these parties; otherwise the excursions will be undertaken with the object of linking up the work of the French expedition with that which Dr. Nordenskjöld and his companions have accomplished, working from the other, or eastern, side of the land masses in this part of the Antarctic region. It is Dr. Charcot's definite intention to return at the end of the season of 1904–5. The *Français*, indeed, is only provisioned for two years, and Dr. Charcot states that if the expedition does not return in the early months of 1905, it must be concluded that they have been involuntarily detained, and a relief vessel must be dispatched to their assistance.

THE Board of Education, in cooperation with the council of the Society of Arts, intends during the present year to hold, in the Victoria and Albert Museum, South Kensington, an exhibition of engravings produced by mechanical means, such as photogravure and other photographic processes, as a sequel to the exhibition of engraving and etching held during last summer; and as great advancements have been made in printing in colours since the Exhibition of Modern Illustration in 1901, specimens of colour printing will be included. A committee, of which Sir William de W. Abney, K.C.B., F.R.S., will act as chairman, has been formed to advise the Board in carrying out the exhibition. All communications should be addressed to the secretary, Exhibition of Mechanical Engraving, Board of Education, South Kensington.

AT the monthly meeting of the Church Society for the Promotion of Kindness to Animals, held on Friday, January 8, at the Church House, Westminster, it was resolved to present a memorial to the Government asking for a departmental inquiry into the conditions under which slaughtering is carried on, and the general treatment of animals. A paper was read on "Nature-Study Conducive to Kindness to Animals" by the Rev. Claude Hinscliff.

MR. J. A. GILRUTH, pathologist to the Public Health Department, Wellington, N.Z., is reported to have made a new discovery with regard to anthrax (*Times*, January 11). The series of experiments which he has conducted proves that an animal particularly susceptible to anthrax, such as a guinea-pig or a rabbit, will resist enormous doses of virulent anthrax provided the anthrax germs be mixed with a greater quantity of another species of microbe that in itself must be non-pathogenic and incapable of producing any disease. These observations may ultimately prove to be of practical importance, and their confirmation will be awaited with interest.

PROF. A. KLOSSOVSKY, of the University of Odessa, and director of the meteorological system of south-west Russia, has published in vol. xxv. of the *Journal* of the New Russian Society of Naturalists a very interesting *résumé* of the general condition of weather prediction at the present time. He deals with the old method of mean values and the modern method of synoptic meteorology, the application of mathematical analysis, with periodicities (varying from two to thirty-five, and even one hundred and thirty-five years), the moon's influence, &c. The chief object of the paper is to examine the method of M. Demtschinsky and the predictions published for some years in the journal *Climate*. The predictions in question have been submitted to an exhaustive examination, and Prof. Klossovsky's conclusions are entirely unfavourable to M. Demtschinsky's method and results. For the benefit of meteorological students the author suggests that, if M. Demtschinsky persists in his views, the matter should be referred to the independent decision of the International Meteorological Committee, and that the necessary funds should be placed at its disposal for the preliminary work of calculation and preparation of diagrams.

EVERY photographer who washes his negatives carefully is aware of the great expenditure of water and time required before he is satisfied that the last trace of hyposulphite of soda has been dissolved. Four hours is sometimes given as the length of time necessary, but usually one hour is considered sufficient. Mr. J. Norton, in the *British Journal of Photography* (January 1), suggests an alternative scheme for getting rid of the hypo in five minutes, and as he says he has given some attention to this question, his process may be summarised here. The basis on which the suggestion is made is that barium chloride has an exceedingly strong affinity for sulphur. On the addition of barium chloride to hyposulphite of soda both are immediately broken up; the barium unites with the sulphur and the soda with the chlorine, so that the products are barium sulphate and common salt. The barium sulphate being loose, very heavy, white (poisonous) powder, quite insoluble, can be easily rinsed off the photographs, and the common salt remains in the solution. After the photograph has been taken from the hyposulphite of soda solution, it should be rinsed in running water for a minute and rubbed on both sides with a cotton swab. It should then be dipped for two minutes in a 5 per cent. solution of barium chloride, and afterwards rinsed and swabbed in running water. Mr. Norton finds that five minutes is sufficient for this latter manipulation. He also remarks that the whites of the photographs are improved by this process.

Two small booklets on "Color Correct Photography" and "How a Lens Works," belonging to the "Photogram Series of Penny Pamphlets on Photography," have been received from the publishers, Messrs. Dawbarn and Ward, Ltd. The first contains some facts about isochromatic and orthochromatic methods which will aid the photographer to improve his work both from the technical and pictorial points of view. The second tells one what the lens can and cannot do, and gives in simple language various pieces of information useful to a beginner. This useful series of pamphlets will no doubt find many readers.

AN account of the development of mathematics during the nineteenth century is contributed by Dr. J. T. Merz to the *Proceedings* of the Durham University Philosophical Society.

IN a paper contributed to the *Physikalische Zeitschrift*, iv., 30, by Messrs. R. Luther and W. A. Uschkoff on the chemical action of Röntgen rays on bromide-gelatin photographic plates, the authors arrive at the conclusions (1) that the action of these rays is specifically different from that of ordinary light; (2) that short exposure to Röntgen rays alters the sensitiveness of the plates to ordinary light, sometimes increasing and sometimes decreasing it; (3) that previous illumination with ordinary light does not affect the behaviour of bromide plates towards Röntgen rays.

SEVERAL papers have recently appeared dealing with the study of ultra-microscopical particles. In the *Revue générale des Sciences* MM. A. Cotton and H. Mouton give a general account of the recent researches of Siedentopf and Zsigmondy, and Mr. E. Raehlmann, of Weimar, contributes to the *Physikalische Zeitschrift* the results of his researches on the ultra-microscopic particles contained in solutions of colouring matters, these researches having been carried out with the aid of the instrument belonging to the Zeiss Laboratory in Jena.

THE recent attempts of engineers and others to grapple with thermodynamical problems falling more strictly within the domain of the physicist have led to the publication of a paper by Prof. W. S. Franklin in *Science* for November 20, 1903, on the misuse of physics by biologists and engineers. In discussing irreversible processes, the author introduces the new nomenclature of "steady sweeps," "trailing sweeps," and "simple sweeps," and he maintains the view (rightly or wrongly) that the conception of *temperature* has no meaning except in cases of thermal equilibrium.

FROM the Gesellschaft für drahtlose Telegraphie we have received reprints of papers from the *Elektrotechnische Zeitschrift* dealing with a new detector for wireless telegraphy and a new measurer for electric waves. The detector, which is described by Mr. W. Schloemilch, depends on the property that when electric waves fall on a polarised electrolytic cell placed in circuit with a source of current of slightly higher E.M.F., the current in the circuit is increased either owing to a decrease of the resistance due to polarisation or from some other cause. The name "System Telefunken" has been given to this new method of wireless telegraphy.

IN *Science* for December 18, 1903, Dr. G. F. Kunz and Prof. C. Baskerville describe a series of observations made on the conduct of the gems and gem material of the Tiffany Morgan collection, and on several other collections of diamonds, under the influence of radium, Röntgen rays, and ultra-violet light. The fluorescence and phosphorescence were tested for more than 13,000 verified minerals. Seeing that three different kinds of radiation are considered, and that a mineral may respond or fail to respond to any one of them, the "number of ways" (to quote the familiar question on permutations) is eight, and the authors propose a tentative classification of minerals based on these eight ways. It is further pointed out that we have here a series of discriminating tests which may be readily applied to various minerals with the use of comparatively simple apparatus.

ON March 16, 1882, the late Prof. Adolfo Bartoli communicated a sealed packet to the Accademia dei Lincei, of Rome. This packet was opened at the meeting of the mathematical and physical section on February 1 of last year, and found to contain a paper on the transformation into electric currents of the radiations falling on a reflecting surface in motion. In this paper, which is published in the *Atti dei Lincei*, xii., 9, the author discusses a method, previously described, of conveying radiation from a cold body to a hot one by means of deformable reflectors, and among the various kinds of forces necessary to reconcile this result with thermodynamics, the author suggests pressure due to radiation, and the production of tangential currents when a reflecting surface is rotating rapidly in sunshine. It is interesting to note that the first explanation, which is now well established, led in Bartoli's time to no conclusive results, while his experiments clearly indicated the existence of the currents required for the second explanation.

A LIST of the flora of the Valle Anzasca (Macugnaga), on the Italian side of Monte Rosa, is given by M. Francesco Ardissone in the Lombardy *Rendiconti*. The valley in question, which is rarely if ever explicitly mentioned in botanical works, is remarkable for its large representation of the order Crassulaceæ, and in addition the author describes a new species of Androsace under the name *A. heterophylla*.

IN the *Memoirs* of the Boston Society of Natural History Prof. Jeffrey has published the first of a series of memoirs which will be devoted to the comparative anatomy and phylogeny of the Coniferæ. The genus Sequoia forms the subject of this paper, and considerable importance is attached to the distribution of the resin ducts. A similar distribution is found to occur in species of the genus Abies, whence Prof. Jeffrey is led to postulate the derivation of the living Sequoias from an abietineous stock.

THE experiment of fixing a seed to the side of a dish containing mercury so that the root of the seedling may force its way downwards into the mercury is a common one. It is not generally known that with certain seeds the penetration of the roots into the mercury may be effected without any fixation beyond the film of water which must be placed on the mercury to keep the root moist. In the *Proceedings* of the Amsterdam Royal Academy of Science Mr. P. van Harreveld discusses the controversies which have arisen out of this experiment, originally performed by Pinot in 1829. In a paper from the same source Dr. and Mrs. Th. Weevers bring forward evidence to show that alkaloids are formed synthetically in the young parts of such plants as tea, coffee, and cacao, and that in older parts they are wanting; the conclusion is that they are used up in metabolism.

HAVING regard to the present and future condition of the cotton industry in this country, very great interest attaches to the results of the trials which are being made to introduce the cultivation of cotton into our colonies. For the benefit of those disposed to take up cotton growing in the West Indies, the Imperial Commissioner of Agriculture has brought together in the last number of the *West Indian Bulletin* a series of articles dealing with the cultivation, chemistry and diseases of cotton. A point of primary importance is the careful selection of seed, for not only has the Sea Island cotton been improved by judicious selection, but the Rivers variety, which is resistant to the wilt disease, was obtained in the same way. Experimental plots were only started in St. Kitts, Antigua, Montserrat, and Barbados last year, so that it is too early as yet to obtain trustworthy data.

CAPTAIN STANLEY FLOWER has favoured us with a copy of the second edition of the "Guidebook" to the Zoological Gardens under his care at Giza, near Cairo. A brief account of many of the more interesting species in the collection is given. It is satisfactory to learn that the three specimens of the shoe-billed stork are still thriving.

THE January number of the *Entomologists' Monthly Magazine* contains several items of special interest. In one note Prof. T. H. Beare records the occurrence in two localities of a foreign beetle (*Ptinus tectus*) recently introduced into this country. The native home of this beetle is apparently Tasmania, but one of the introduced colonies came from the Levant. In another communication Mr. N. H. Joy records a Russian beetle, *Euconnus macklini*, as British. Mr. W. E. Clarke, in recording several kinds of insects—chiefly moths—observed at the Eddystone Lighthouse, touches a practically new subject, namely, the wanderings and migrations of insects.

MR. P. W. STUART-MENTEATH has sent us a pamphlet on "Pyrenean Geology, part i., the Alpine Paradoxes" (Dulau and Co., 1903, price 1s.). This is a controversial essay on the structure of the Alps and Pyrenees, and on errors in the geological maps of those regions.

THE *Journal* of the Royal Microscopical Society for December, 1903, contains the usual summary of current researches relating to zoology and botany (principally Invertebrata and Cryptogamia), microscopy, &c., and in addition there is part xv. of Mr. F. W. Millett's report on the recent Foraminifera of the Malay Archipelago.

THE fossil echinoids of Japan have been described by Mr. S. Tokunaga (formerly Yoshiwara), the species being illustrated by four plates (*Journ.* Coll. Science, Tokyo, vol. xvii., art. 12, 1903). No echinoids have been found in the Palæozoic strata of Japan; the Mesozoic strata have yielded Pygurus, Toxaster, Cidaris, Pseudocidaris and Hemici-

daris (?); and eighteen genera are recorded from the Cainozoic series. Most of these last-named genera are still living, and some of the species have a wide geographical distribution and a considerable range in Tertiary time.

MR. A. LUCAS has prepared, for the Public Works Ministry at Cairo (1903), a report on the soil and water of the Wadi Tumilat lands. It appears that this alluvial tract formed part of "the land of Goschen," and was a fertile tract until ruined by the Ismailia Canal. The author points out that this high-level canal passes through a porous soil, and the seepage-water has not only raised the general level of the subsoil water, but has brought to the surface in many places salts of soda which have proved more or less injurious, the sodium carbonate being most harmful to vegetation. Wind also helps to distribute the efflorescent salts. The remedy consists in a thorough system of drainage, and in frequent washing of the land.

WE have received a copy of the "New and Revised Edition of a Geological Map of the Southern Transvaal," by Dr. F. H. Hatch (Stanford, price 20*s*. in sheet, 25*s*. in case), with explanatory pamphlet (1903). The scale of the map is a little more than four miles to an inch, and it includes an area bounded on the north by Pretoria, on the west by Ventersdorp and Klerksdorp, on the south by the Vaal River, and on the east by Greylingstadt and Heidelberg. It is very clearly printed in colours, and the farm boundaries are shown. Although admittedly a sketch-map, it will be of great service in representing the present state of knowledge with regard to the extent of the coal-bearing strata, the auriferous rocks and other mineral resources, not to mention the Dolomite series, which is economically of great importance as the source of perennial streams and as furnishing the present water-supply of Johannesburg.

SYSTEMATIC and distributional arrangements of the genus Polygonum in India have been prepared by Captain Gage, and are published in the *Records* of the Botanical Survey of India. The horizontal distribution of the species throughout certain sub-subareas of India compared with their distribution in other countries is well shown in one set of tables, and another set indicates the vertical distribution. From the latter it will be observed that *Polygonum viviparum* shows the greatest vertical range, namely, from 4000 to 17,000 feet; *Polygonum tortuosum* and *Polygonum sibiricum* reach to the same upper limit, but are not found below 11,000 feet.

IN the notice of "Le Point critique des Corps purs" in last week's NATURE (p. 217) it should have been stated that the author of the book is Prof. E. Mathias.

MESSRS. WATTS AND CO. have issued for the Rationalist Press Association sixpenny editions of "Science and Speculation," by Mr. C. H. Lewes, and of Mr. Edward Clodd's "Story of Creation." The latter volume contains eighty-six illustrations and tables.

THE Brin Oxygen Companies, the London address of which is now Elverton Street, Westminster, S.W., have issued a convenient little diary which is provided with much useful information. Not only are full particulars of the prices of the apparatus made by the companies and of the compressed gases supplied by them included, but also a series of hints to users of compressed gases in the form of medical notes, notes for lanternists, for blowpipe users, and on extreme refrigeration. In addition, the booklet contains a cylinder record and instructions for using liquefied carbon dioxide.

WE have just received an advance copy of Merck's English catalogue of fine chemicals. The list of chemicals is very comprehensive, and is probably the most complete published in this country. We note that Merck's present factory in Darmstadt will soon be replaced by entirely new works, now in course of erection.

IN the current number of the *American Journal of Science* Mr. J. C. Blake points out that soluble silver compounds are formed in the preparation of colloidal silver solutions by sparking between silver electrodes under water. It seems probable to the author that these compounds may play an important part in the peculiar actions exhibited by colloidal metal solutions, which, from the similarity of their behaviour to that of ferments, have been styled by Bredig inorganic ferments.

IN the *Proceedings* of the American Academy of Arts and Sciences Mr. G. P. Baxter describes some further experiments relative to the atomic weight of iron, an entirely new method—the analysis of ferrous bromide—being employed. These new experiments confirm the result, 55·88, previously obtained by Richards and Baxter for the atomic weight by the reduction of the oxide, and indicate that the value, 56·0, usually employed is appreciably inaccurate.

A NEW form of electrical resistance furnace was described by Dr. Frölich at the last meeting of the German "Bunsen" Society for Applied Physical Chemistry. Instead of employing carbon cores as the immediate source of heat, the sides of the furnace itself are utilised, the furnace being constructed of some specially suitable material the nature of which has not been divulged. The mean temperatures reached in a core furnace and in that described by the author under comparative conditions were found to be 1200° and 1600° C.

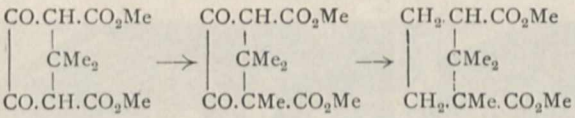
THE first number of a new review, the *Physikalisch-chemisches Centralblatt*, has just been issued. It is not intended as a medium for the publication of original work, but as a comprehensive centralising review of progress in physical chemistry, the extraordinarily rapid rise and development of which during the last decade is almost unique in the history of science. The abstracts are to appear either in German, English, or French, and, so far as possible, will be furnished by the authors themselves. The review will be issued twice a month, and will no doubt be a valuable aid to the numerous chemists who desire to keep abreast of physicochemical literature.

THE oxidation of phosphorus is a reaction which, in spite of its apparently simple nature, exhibits many anomalies. The rate of oxidation increases as the pressure diminishes, and no completely satisfactory explanation of this apparent exception to the law of mass action has yet been given. In the current number of the *Journal* of the Chemical Society Mr. E. J. Russell contributes a further series of observations on the subject. It appears that the presence of a small quantity of water is necessary for the oxidation, and that the quantity left after drying with sulphuric acid is that which allows reaction to proceed most rapidly. The results of experiments carried out at higher pressures contradict the usual statement that phosphorus only reacts with oxygen at low pressures, and the author finds that the reaction in these circumstances is in agreement with the mass action law.

A NOVEL reducing agent is described by Dr. Stoermer in a recent number of the *Berichte*. He has found that in a considerable number of cases compounds containing the group $-CH_2.CO-$ are reduced by heating with phosphorus

tribromide to unsaturated compounds containing the group —CH : CH—. Thus desoxybenzoin, $C_6H_5.CH_2.CO.C_6H_5$, is reduced to stilbene, $C_6H_5.CH : CH.C_6H_5$, and diphenylpyrazolone to diphenylpyrazole. The method is also applicable to some compounds containing the group —NH.CO—, and carbostyril is in part reduced by phosphorus tribromide to quinoline.

THE long sought synthesis of camphoric acid has been recently accomplished by Dr. Komppa, of Helsingfors (Finland), and is described in the *Berichte* of December 29, 1903. Two years ago the author described the synthesis of apocamphoric acid, which differs from camphoric acid only in the presence of a hydrogen atom in place of one of the methyl groups. The methyl group cannot be introduced directly into apocamphoric acid, but the diketo-apocamphoric ester can be methylated and yields a diketocamphoric acid which can be indirectly reduced to camphoric acid,



The synthetical acid is optically inactive, but proved to be identical with the known racemic form of camphoric acid. The synthesis includes also the preparation of camphor from its elements, since the conversion of camphoric acid into camphor was accomplished some years ago by Haller. Although the correctness of Bredt's formula for camphor has been fully established by the synthesis of several of its oxidation products, the synthesis of the ketone itself has for some years been one of the most attractive problems in organic chemistry, and its solution completes a not unimportant chapter in the history of chemical progress.

THE additions to the Zoological Society's Gardens during the past week include a Raven (*Corvus corax*), British, presented by Mr. George Ogilvie; a Mongoose Lemur (*Lemur mongoz*) from Madagascar, two Sulphury Tyrants (*Pitangus sulphuratus*) from South America, deposited; a Llama (*Lama peruana*), born in the Gardens.

OUR ASTRONOMICAL COLUMN.

DISTRIBUTION OF THE STARS.—No. 5, vol. xlviii., of the Harvard College Observatory *Annals* contains a discussion of the distribution of the stars throughout the whole sky. A special point of the discussion was to determine the relative numbers of the stars situated in the Milky Way and those outside its limits. The number of stars in the galaxy was determined from the charts given in Heis's atlas and the Uranometria Argentina; those without were determined from the Harvard Durchmusterungs. Twenty-three tables included in the paper set out the various results in detail, but the following are among the chief facts determined.

The number of stars in a given area of the Milky Way is about twice as great as in an equal area of any other region, and this ratio does not increase for faint stars down to the twelfth magnitude; the proportion of stars of any given magnitude is the same in the Milky Way as in the other regions. The Milky Way covers about one-third of the sky, and contains about half of the stars. There is no evidence of any limit to the faintness of the stars, although the proportionate increase becomes less for each successive magnitude. There are about 10,000 stars of magnitude 6·6 or brighter, 100,000 of magnitude 8·7, 1,000,000 of magnitude 11·0, and 2,000,000 of magnitude 11·9. Although uncertain, it is suggested that there are about eighteen millions of stars visible in a telescope of 15 inches aperture, *i.e.* down to about the fifteenth magnitude.

The distribution of various spectral types has also been considered, and the most striking fact is the preponderance of stars of class "A" and "K" (Harvard), which in a general classification may be taken as typical spectra, the others being simply modifications of these. Many other extremely interesting facts have been elicited during the discussion, but they are too numerous to mention here.

REPORT OF THE WINDSOR, N.S.W., OBSERVATORY.—Mr. Tebbutt's report of the work performed at this observatory (Windsor, N.S.W.) during 1902 deals chiefly with meridian observations for the determination of local time and star places. Most of the extra-meridian work mentioned has already been published in the *Astronomische Nachrichten*, and includes observations of minor planets (for positions) and Perrine's comet (1902 *b*). The reduced measures of fifty-four of the double-stars given in Inne's "Reference Catalogue," involving 1757 settings for position angle and 1503 for distance, have been communicated to the Royal Astronomical Society. The local meteorological results, given in the report, include monthly returns of temperature and rainfall observations, and show that the number of inches, recorded by a rain-gauge placed about 7 feet above the ground, is less than for any year since 1863, being, in fact, about 14·5 inches below the average for forty years. A number of comparisons of the temperatures recorded by two thermometers, one in a Greenwich the other in a Stevenson screen, showed that an excess amounting to between one and two degrees was registered by the former.

A FRENCH-CHINESE CALENDAR.—The "Calendrier Annuaire" for 1904, compiled at the Li-Ka-Wei Observatory, and published at the price of one dollar by the Catholic Mission at Shanghai, is an interesting calendar containing many astronomical, meteorological and physical tables.

The calendar is printed in French, but all proper names and technical terms are also given in Chinese characters and words. Among the more important matters dealt with there occur a lucid explanation of the Chinese calendar, many astronomical tables and explanatory notes, tables for the conversion of Chinese and Japanese standards into European equivalents, facts regarding the population, area and political relations of China, and a number of tables and curves relating to the meteorology of the Chinese Empire.

A BRIGHT BOLIDE.—A remarkable bolide was observed by Mr. W. E. Rolston at Fulham at about 8h. 27m. p.m. on January 9. It appeared at a point situated at about $\alpha = 102°$, $\delta = +18°$, and slowly travelled towards the constellation Cancer, leaving a bright, scintillating, reddish trail. When near to the point $\alpha = 112°$, $\delta = +18°$ (approx.) the head slowly swelled out into a bulbous shape having a yellowish-red hue, became considerably brighter than Jupiter, and then suddenly disappeared. The duration of the complete phenomenon was about five or six seconds.

THE PHYSICAL LABORATORY AT LEYDEN.

AN account of this laboratory, published in NATURE of August 13, 1896 (vol. liv. p. 345), dealt with the inception of the cryogenic department in 1883, and traced its development up to date. It is the purpose of this note to continue the account to the present time, both as regards the more important changes and improvements in the cryogenic department itself, and also in the remaining divisions of the laboratory.

As before, the communications continue to give an almost complete account of the results of the practical work carried out, together with certain more theoretical papers in direct connection with this. Since 1898, the Royal Academy of Amsterdam has published its *Proceedings* in English as well as in Dutch, so that the communications are now corrected reprints of the *Proceedings*. Some idea may be gathered of the increasing output of work when it is noted that in 1896 the current number of the communications was twenty-three, while it has now risen to eighty-eight.

This increasing productivity is mainly due to the much improved appliances, both for manipulation and measurement, which have been developed during the last ten years. Although the original system of three main cycles containing methyl chloride, ethylene and oxygen has been retained, almost every part has been improved and enlarged, so that the ease and rapidity of working are much enhanced. In

addition several auxiliary circulations have been constructed in order to add new ranges of temperature to those already obtainable by the main cycles, or at least to make certain temperatures more practicable. Of these the principal are:—(1) a circulation of strong calcium chloride solution cooled to about −23° C. by methyl chloride, and then heated again to the required constant temperature in a thermostat; (2) a nitrous oxide circulation, also in connection with the methyl chloride, for temperatures about −90° C.; (3) air; (4) nitrogen; and (5) methane in connection with the oxygen cycle. In this way the entire range between +5° and −210° can be covered with but few gaps.

The efficiency of the circulations is now very high, as each step in the cascade only lasts about 20 minutes, so that liquid nitrogen even, which requires four operations, is obtained in 1 hour 20 minutes. For this purpose about 6 kg. methyl chloride, 1·3 kg. ethylene, 2·5 kg. oxygen, and 1·0 kg. nitrogen are required, with the pumps running at about 5, 6, 30, and 6 atmospheres pressure in the respective cycles. In order to obtain this speed of work a new large Burckhardt-Weiss pump, with a capacity of 100 litres per second and capable of evacuating to 2 mm. of mercury, has been introduced before the vacuum cylinder of the Pictet conjugated pump in both methyl chloride and ethylene circulations. In the case when a bath of liquid nitrogen is required, one of the two Brotherhood compressors is put into the oxygen circulation, while the nitrogen is compressed in the modified Cailletet pump mentioned before, after passing through an auxiliary pump, to bring it to about 10 atmospheres pressure.

Two methods are employed for conveying the liquid gas required from the cryogenic room to one of three experimenting rooms. Where many measurements at a reduced temperature are desired, hence necessitating a frequent addition of liquid, methyl chloride, nitrous oxide, and ethylene have been conveyed in a copper tube well wrapped up in wool and paper for a distance of about 10 metres. In other cases the liquid is run into specially mounted vacuum glasses, which are transported to the experimental vessel, into which the liquid is siphoned over. Measurements have been made in this way with all the gases mentioned, in vessels which require the use of litres of liquid.

One of Prof. Onnes's chief objects in founding his cryogenic department was the experimental determination of accurate isothermals of pure elementary gases and their binary mixtures, at temperatures near the critical. Although measurements had been made on methyl chloride, carbon dioxide, and mixtures of these with oxygen or hydrogen, no measurements on the latter gases alone had been attempted until about four years ago. The first necessity was a standard open mercury manometer for the very accurate determination of pressures up to 64 atmospheres. Since this has been available, measurements have been made on hydrogen, oxygen, and nitrogen at ordinary and at low temperatures to an accuracy unattained before in such work. At the same time very careful comparisons have been made between the expansion coefficients, at constant volume, of the same gases at low temperatures. In order that these measurements should be possible, it was also necessary to develop the system for the determination of temperature to the accuracy required. For this purpose use has been made of constant volume hydrogen thermometers and of specially prepared and calibrated platinum resistances or thermoelements.

For the most recent measurements it has been found advisable to employ, at the same time, both a temperature indicator and a temperature measurer. The measuring instrument must be sensitive enough for the accuracy required, but the indicator must be set to a higher order. A combination of a platinum resistance, wound upon glass and surrounding the experimental tube, with a thermoelement has usually been employed.

The temperature of an evaporating liquid varies both from the want of homogeneity of the substance and of constancy in the pressure. By suitable adjustment of the pressure, it is possible to make these variations compensate one another, with the result that a nearly constant temperature is obtained. In the thermoelectric circuit variations of 0·01 degree can be immediately seen and corrected by a suitable small change of pressure. Variations due to the pumping machinery and other similar causes are corrected at once from the indications of an oil manometer. In addition, continual stirring by a small motor allows temperatures down to −210° C. to be obtained, which remain constant and uniform to 0·01 degree for an hour in baths 15 cm. in depth.

Preparations are now being made, by the addition of new pumps and other apparatus, for the installation, on the same principles, of a hydrogen cryostate, which will allow of the extension of the range of constant temperatures to the boiling point of hydrogen under reduced pressure.

Since only minor technical difficulties are to be expected, it is probable that this cycle will be completed in a few years' time.

During the past decade several other important investigations have been made. Of these the best known is certainly the discovery and measurement by Dr. Zeeman of the effect which goes by his name. This was largely due to a set of careful experiments and measurements on

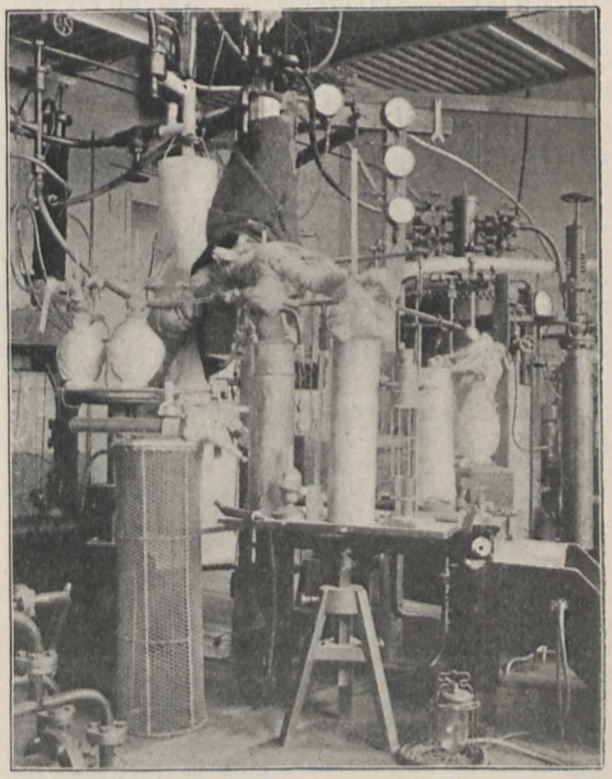


FIG. 1.—The immediate apparatus for the preparation of liquid nitrogen or methane. The liquefied gas is being collected in the metal cylinders in middle of picture. This apparatus stands at the end of the room from which the view shown in 1896 was taken.

kindred optical questions, and was tried several times without success. Immediately it was noticed Prof. Lorentz was able to supply the elementary theory, which has subsequently only been elaborated. The discovery thus belongs peculiarly to Leyden, while the partnership was fittingly acknowledged by the joint award of the Nobel prize in 1902.

What Prof. Onnes considers as to some extent a new method of thermodynamical research has been recently developed by him. It consists in making large accurate models of both the Gibbs (ϵ, η, v) and van der Waals (ψ, v, x) surfaces. By means of these many problems can be treated with comparative ease, which otherwise would either be impossible or would involve very lengthy calculations.

The following list of the principal researches from the beginning of the communications will show clearly the range of work covered.

To make it a continuation of that in the former note the same numbers have been retained :—

(1) Cryogenic department. Pumps, cycles, experimental apparatus, &c. (Nos. 14, 23, 51, 54, 85).

(2) Investigations regarding condensation of mixtures (Kuenen, Nos. 4, 7, 8, 11, 13, 16, 17; Hartman, Nos. 43, 56, 64, Supplement 3; Verschaffelt, Nos. 45, 47, 55, 65; Keesom, 88).

(3) Measurements on capillarity (de Vries, No. 6; Verschaffelt, Nos. 18, 28, 32; van Eldik, No. 39).

(4) Measurements on viscosity of methyl chloride (Stoel and Haas, Nos. 2, 12).

(5) Experiments on Kerr's magneto-optical phenomenon (Sissingh, Wind and Zeeman, Nos. 1, 3, 5, 8, 9, 10, 15, 20); on the influence of magnetism on light (Zeeman, Nos. 29 33, 36).

(6) Measurements of the Hall phenomenon in bismuth (Lebret, Nos. 15, 19; van Everdingen, Supplement 2, 61, 63. 72).

(7) On Hertz waves in water and electrolytes (Zeeman, Nos. 21, 22, and with Cohn, No. 30).

(8) The dispersion of the magnetic rotation in gases and liquid gases (Siertsema, Supplement 1, Nos. 62, 73, 76, 80, 82).

(9) The accurate measurement of very low temperatures (Kamerlingh Onnes, Nos. 27, 44, 50, and Boudin, No. 60, and Heuse, No. 87; Meilink, No. 77).

(10) Dielectric constants of liquid gases (Hasenoehrl, No. 52).

(11) Accurate isothermals and critical constants of diatomic gases (Schalkwyk, Nos. 67, 70; Kamerlingh Onnes and Hyndman, Nos. 69, 78, 84).

(12) Contributions to the knowledge of van der Waals's ψ surface (Kamerlingh Onnes, Nos. 59*a*, 66, and Reinganum, No. 59*b*, and Happel, No. 86; Keesom, Nos. 75, 79; Verschaffelt, No. 81).

(13) The expression of equations of state by means of series (Kamerlingh Onnes, Nos. 72, 74).

In addition, measurements have been made at low temperatures, and will be published shortly, relating to the pressure coefficient of oxygen and nitrogen at both ordinary and high pressures, and also to the critical phenomena and constants of oxygen.

At the present time the electrical installations of the laboratory are being largely increased. There are already three dynamos which can give a current of 200 amperes at 120 volts, and two motors will be ready shortly to drive some of the pumps and other apparatus.

The possibility of making and fitting the highly specialised and intricate apparatus required for some of these measurements is largely aided by the circumstance that the laboratory is combined with a technical school for instrument making and certain branches of electrical technology. About twenty apprentices are at present passing through the wood, metal, and glass workshops, each of which is controlled by a skilled workman. In this way the construction and repair of apparatus, and the help required for complicated experiments, can be obtained in a most satisfactory manner. This unique combination of research laboratory and technical school is well worth a visit from physicists touring in Holland, who will receive a friendly welcome from Prof. Onnes. H. H. F. HYNDMAN.

AUSTRIAN GEOLOGICAL SURVEY.

SOME important publications of the Austrian Geological Survey have reached us, namely, the first part of the twentieth volume of the *Abhandlungen der k.k. Geologischen Reichsanstalt*, Vienna (1903), the second, third and fourth parts of the fifty-second volume and the first part of the fifty-third volume of the *Jahrbuch* (1902–1903).

The first of these works is a valuable memoir by Ernst Kittl, on the Cephalopoda of the Upper Werfen beds of Muć, in Dalmatia, and other localities, and comprises seventy-seven pages and eleven plates. As indicated by the title, the greater part of the material described in this memoir was obtained from the locality discovered in 1862 at Muć (or Much), in northern Dalmatia, but some of the specimens are from other areas, including certain Alpine localities. Some account is given of the various places where similar strata have been met with, and numerous references are made to the writings of other workers. The description of the various genera and species constitutes the bulk of the work. All the forms noticed are included in two families :—(1) the Ceratitidæ, with the genera Dinarites, Stacheites, Ceratites, and Tirolites; and (2) the family Pinacoceratidæ, with the genera Kymatites, Meekoceras, and Dalmatites. Of these genera Stacheites alone is new to science, but certain subgenera and thirty-four species are described and named for the first time.

In conclusion, the author directs special attention to the importance of the few precursors of the Muschelkalk Cephalopoda, such as Dalmatites, Ceratites, and some nearly allied forms, which are now for the first time known to occur in the Werfen beds.

A comparison with the Permian and Carboniferous fauna of Silesia, Russia, and India shows the comparative poverty of the Werfen beds, and the author points out that the scanty fauna goes "hand in hand" with the small amount of calcareous matter in the deposit.

The second part of the *Jahrbuch* indicated above contains several interesting papers on various subjects, each being illustrated by plates or text figures. Dr. Karl Hinterlechner describes the petrographical characters of some rocks from the Cambrians of western Bohemia. The "Erzberg" in Hüttenberg, Carinthia, is described by Bruno Baumgärtel; Dr. Rudolf Zuber gives us some new studies in the Carpathians; while Hermann Bock supplies an account of the physical structure of the neighbourhood of Brünn. Then follow three palæontological papers :—Rich. Joh. Schubert, on some bivalves from the Istro-Dalmatian "Rudistenkalkes"; Vincenz Hilber, on some fossils from the Gosau beds of Kainach and Söding, in the northern parts of Voitsberg—in this paper one new species is described under the name of *Hippurites Styriacus*; Adalbert Liebus and Rich. Joh. Schubert describe the Foraminifera from the Carpathian Inoceramus beds of Gbellan, in Hungary, seven new species and four new varieties being named. The concluding paper, and certainly not the least important, is by Dr. H. Graf Keyserling, and is entitled "Geologico-petrographical Studies in the Region of the Melaphyre and Augiteporphyry of the Southern Tyrol." This is a detailed communication of some forty pages, which will doubtless be carefully studied by all interested in this particular subject.

The third part is devoted to a detailed account of the localities and horizons yielding useful minerals in the so-called Archaic and Devonian island of Westmähren, by Franz Kretschmer, mining engineer at Steinberg. This memoir of 142 pages deals very fully with the geological and physical conditions under which the graphite, lead, iron ores, &c., are found, and it is illustrated by a geologically coloured map, with sections and plans.

The fourth part of this volume is a memoir by A. Bettner on the Brachiopoda and Lamellibranchiata from the Trias of Bosnia, Dalmatia, and Venetia, occupying 149 pages, and illustrated by ten lithographic plates and seventeen zincographs in the text. The greater part of this work deals with fossils of Middle Trias or Muschelkalk age, derived from several localities, but perhaps a greater interest will be attached to the last twenty pages, dealing with the Upper Trias or Keuper forms from two localities in Bosnia. The whole memoir is a detailed description of species, and, as might be expected from their age and the little known localities from which they are derived, many of them prove to be new, but one cannot but be surprised to find that of some two hundred forms here described one hundred require new names. The plates accompanying this work are clearly drawn, but it is to be regretted that the figures are so crowded. All who have worked with such plates know how troublesome this is; one's eyes become dazed when trying to concentrate upon any particular figure. No doubt this memoir, like the one above noticed on the Werfen Cephalopoda, will become a classic in Triassic literature.

Part i. of vol. liii. contains several papers; the first of these, by R. Hoernes, on the ontogeny and phylogeny of

the Cephalopoda, deals with the initial chamber of the Nautiloidea, especially in the genus Orthoceras. Dr. Richard Johann Schubert and Dr. Lukas Waagen give an account of the Lower Silurian phyllopod genus Ribeiria, and establish a new genus, Ribeirella, for the species *R. Sharpei*, Barr. The remains of a male sheep's skull (*Ovis Mannhardi*) from the neighbourhood of Eggenburg are described by F. Toula, and carefully compared with recent and fossil forms; the paper is illustrated by a plate showing three views reproduced by photography and by three text figures. Dr. W. Hammer gives an account of the minute structure of porphyrite and diorite rocks from Ultenthal, giving six excellent photographic reproductions of microscopic sections. Dr. O. Able, in a memoir of some 50 pages, treats of the Tertiary marls and sandstones of the Tulln basin from both stratigraphical and physical standpoints, and comes to the conclusion that they begin with the Lower Oligocene and continue in unbroken series to the base of the Oncophora sands (Middle Miocene). Four sections across the valley are given to show the folding of the beds. Dr. Karl Alphons Penecke, in a paper of a dozen pages, describes a number of Upper Devonian corals obtained by Dr. Franz Scaffer from Hadschin, Antitaurus, during his journey in Asia Minor. Three new species are named. These corals are finely reproduced by photography on four double plates. In the last paper of this part Dr. W. Petrascheck describes some Inocerami from the Chalk of Bohemia and Saxony, giving the names *Ino. hercynieus* and *Ino. crassus* to two new species. This troublesome genus needs a thorough revision, and it is hoped that ere long someone will be found to undertake this useful piece of work, at least for the Cretaceous species.

ATMOSPHERIC ABSORPTION AND EMISSION OF THE EXTREME ULTRA-VIOLET RADIATIONS.

NO. 1413 of the "Smithsonian Contributions to Knowledge" is devoted to a paper by Dr. Victor Schumann, of Leipzig, in which he minutely describes the apparatus used and the results obtained by him in spectroscopically determining the absorption and emission of air and its constituents for light of wave-lengths between 250 $\mu\mu$ and 100 $\mu\mu$. He obtained the photographic spectra of N, O, CO_2, CO, aqueous vapour and hydrogen by means of an ingeniously constructed spectroscope, from which he could exhaust all the gas except that on which he was experimenting, and this he introduced, in layers of definite thicknesses, after repeated purification. All the optical parts of the apparatus were made of white fluorspar, which is the most transparent substance, for these extreme ultra-violet rays, yet known.

Dr. Schumann found that nitrogen is very transparent even beyond 162 $\mu\mu$, but absorbs particular wave-lengths very energetically; the emission spectrum extends beyond 162 $\mu\mu$. Oxygen absorbs the radiations near to 185 $\mu\mu$ in a series of clearly resolved groups of lines, fourteen in number, complete absorption taking place beyond the most refrangible group of the series. This absorption is believed to be the cause of the atmosphere's opacity for radiations more refrangible than 185 $\mu\mu$. The absorption spectrum of CO_2 is similar in appearance to that of oxygen, but extends to much shorter wave-lengths; the persistent presence of bands due to carbon monoxide—which is one of the greatest difficulties Dr. Schumann has had to contend with in all his experiments, because their photographic action is exceedingly energetic and they extend far beyond 162 $\mu\mu$—has prevented the exact determination of the more refrangible limit of the CO_2 spectrum, which is exceedingly rich in lines. Carbon monoxide absorbs the more refrangible rays a little less than CO_2. The results of the experiments on the spectrum of aqueous vapour are rather uncertain owing to the formation of dew, but it chiefly consists of the hydrogen spectrum, the strong oxygen maximum at 185 $\mu\mu$, and a number of other lines the origin of which is at present unknown. The results, however, lead to the conclusion that a regular dissociation of the water vapour, accompanied by a simultaneous recombination, takes place. The results obtained with hydrogen are exceedingly interesting, and are discussed *in extenso* by Dr. Schumann. They show that hydrogen is intensely transparent, but the limit of transparency is not yet definitely determined. Twenty-fold enlargements of the hydrogen spectrum—having a total length of 1·4 metres—are reproduced in the paper, and show about 1500 lines between 185 $\mu\mu$ and 127 $\mu\mu$. Dr. Schumann states, however, that this latter value is rather uncertain, and is probably not the inferior limit of the true hydrogen spectrum as photographed by him. He also believes that between 185 $\mu\mu$ and 369·9 $\mu\mu$ the hydrogen spectrum is continuous.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

MR. S. A. F. WHITE, demonstrator in natural philosophy in King's College, London, since 1895, has been appointed professor of mathematics in succession to Prof. Hudson.

DR. W. A. OSBORNE has been appointed to the professorship of physiology and histology in the University of Melbourne in succession to Dr. C. J. Martin, F.R.S., now director of the Lister Institute.

THE Technical Education Board of the London County Council has arranged for two courses of free lectures for teachers to be given at the Horniman Museum, London Road, Forest Hill, S.E., on Saturday mornings from January 23 to May 26. Prof. Geddes will lecture on the natural history of plants, and a course of lectures on the natural history of man will be given by Prof. Alfred C. Haddon, F.R.S.

THE annual meeting of the Association of Public School Science Masters will be held at Westminster School on Saturday, January 16, beginning at 1.45 p.m. Prof. W. A. Tilden, F.R.S., president of the Association, will be in the chair. Mr. R. E. Thwaites will read a paper on the possibility of fusing the mathematical and science teaching of public schools; and a discussion on science in the certificate examination will be opened by Mr. W. A. Shenstone, F.R.S., and Mr. M. D. Hill, who will deal with the chemical and biological parts of the examination respectively. Mr. O. H. Latter will read a paper on nature-study.

THE eleventh annual general meeting of the Association of Technical Institutions will be held on Friday, January 29, at the Leathersellers' Hall, London, E.C., the president, Sir John Wolfe Barry, K.C.B., F.R.S., in the chair. Sir John E. Gorst, K.C., M.P., has consented to be nominated president of the association for the year 1904. Among other subjects to be brought before the meeting are:—Report as to the constitution of the advisory committee for the leather trades industries, in connection with the City and Guilds of London Institute, Prof. Wertheimer; the differences between the curricula and methods of staffing in British and American higher technical institutions, Dr. Walmsley; the consultative committee of the Board of Education and teachers' registration council, Principal Wells and Dr. Sumpner; and leaving certificates for secondary schools, Prof. Wertheimer and Principal Gannon.

AN interesting essay by Dr. Walther Schoenichen on "The Evolution Theory in Schools" (Die Abstammungslehre im Unterrichte der Schule) has been published by the firm of Teubner (Leipzig and Berlin). The author shows that school instruction in botany and zoology has already passed through several phases—encyclopædic, systematic, analytic, and ethological—and maintains that the time has come for making it frankly evolutionary. This is necessary for scientific reasons and desirable for educational reasons, and, according to the author, it is also quite feasible. He argues that it will be useful ethically and will not endanger religion. The essay is wise and temperate, and many of the practical hints are very suggestive, *e.g.* the diagrams contrasting the multiplication of the hare and the elephant, the evolution of the kohl-rabi cabbage, and the origin of light-coloured from dark-coloured mice by selection.

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, November 19, 1903.—"On the Physiological Action and Antidotes of Colubrine and Viperine Snake Venoms." By Dr. Leonard **Rogers.** Communicated by Dr. A. D. Waller, F.R.S.

The actions of various venoms have been studied by means of respiratory and circulatory tracings, &c. Firstly, the poisonous colubrine Indian snakes were dealt with. The *Loia bungarus* or hamadryad, the largest poisonous snake in India, was found to cause death by paralysing the respiratory centre, quickly followed by the motor end plates of the phrenic nerves, just as in the case of cobra. The *Bungarus coeruleus,* or common krait, also produced the same effect, only the end plate action was less marked. The *Bungarus fasciatus,* or banded krait, produced similar symptoms to the above in small doses, with the addition of marked circulatory failure, and in large doses also intravascular clotting like the vipers, and its venom was found to be a mixture of colubrine and viperine elements. The hæmolytic action of the above three venoms was much less marked than in the case of cobra venom, and has no lethal importance. The physiological action of the above and of the sea snakes having been found similar to that of cobra venom (with the exception of the added viperine element in the *Bungarus fasciatus*), Calmette antivenin was tested against them all, and found to be effective in varying degrees in each with the exception of the *Bungarus fasciatus*, in the case of which the colubrine element alone is neutralised, but the viperine one proves fatal. The serum is not, however, strong enough to be of the greatest value.

Secondly, the two true vipers, the *Daboia russellii* and the African puff adder, and two pit vipers, the *Crotalus horridus* and the *Trimenurus anamallensis*, were examined, and it was found that the one essential action common to all four was a paralysis of the central vasomotor centre producing a marked fall of blood pressure, followed sooner or later by secondary respiratory failure, but counteracted in a marked degree for a time by adrenal extract. In the case of the true vipers, large doses produce intravascular clotting, but by giving small preliminary doses, fatal vasomotor paralysis can readily be induced without any clotting whatever, while the venom of the rattlesnake readily produces the same effect without clotting in a single large dose, and also marked hæmorrhages, which are not caused by the Daboia.

December 3, 1903.—"On the Fructification of *Neuropteris heterophylla*, Brongniart." By Robert **Kidston,** F.R.S.

Royal Microscopical Society, December 16, 1903.—Dr. Hy. Woodward, F.R.S., president, in the chair.—Mr. F. W. Watson **Baker** exhibited under microscopes a series of slides, sixteen in number, illustrating the development of an ascidian from the fertilisation of the ovum to the larval stage.—Dr. G. J. **Hinde** read a paper on the structure and affinities of the genus Porosphæra.

MANCHESTER.

Literary and Philosophical Society, December 1, 1903.—Prof. W. Boyd Dawkins, president, in the chair.—The president directed the attention of the meeting to the fact that, although the rainfall during the last six months had been unusually heavy, the water in the deep springs had not increased proportionally, but was still below the average quantity for the last ten years.—Dr. W. E. **Hoyle** exhibited a model of the mole's nest, prepared by Mr. Lionel E. Adams, who read a paper on the subject before the Society some time ago. The model is in three parts, and shows the construction of a typical nest of the male mole very clearly.—Mr. F. F. **Laidlaw** read a paper entitled "Suggestions for a Revision of the Classification of the Polyclad Turbellaria," in which he considered more especially the acotylean genera, and based his classification of them on the characters of the prostate gland.

December 15, 1903.—Mr. Charles Bailey in the chair.—Prof. E. **Knecht** read a paper on an interesting reaction of copper salts. More than fifty years ago, Ebelmen had, in describing the properties of titanium trichloride, alluded to the property which this substance possesses of precipitating gold, silver, and mercury from their salts. The author showed that by using an excess of the trichloride, metallic copper could be precipitated from solutions of its salts, but pointed out that the reaction was a reversible one, and was consequently not complete. With titanous sulphate, however, the reaction with copper salts was complete, the copper appearing as an extremely fine metallic looking precipitate even in very dilute solutions (1 pt. in 1,000,000).—The electrolytic method for the detection and approximate estimation of minute quantities of arsenic in malt, beer, and food stuffs, by Mr. W. **Thomson.** An exhaustive series of tests has been made with the electrolytic apparatus devised by the committee appointed by the Commissioners of Inland Revenue in comparison with those obtained by the Marsh-Berzelius apparatus. From the results obtained the author lays stress on the importance of destroying the organic matter in beer, malt, &c., before introducing into the apparatus, and also puts forward the electrolytic method with zinc kathode as the most satisfactory for the estimation of minute quantities of arsenic.

DUBLIN.

Royal Irish Academy, Dec. 14, 1903.—Prof. R. Atkinson, president, in the chair.—Some new relations in the theory of screws, by Prof. C. J. **Joly.** Let A, B, C be any three points on the axes of any three screws, (1), (2) and (3) respectively, of a given three-system. Let B_1C_1 be the projection of BC on the axis of (1). Let (23) be the angle between the axes of the screws (2) and (3), and let sin (123) be the sine of the solid angle determined by the three axes. Then

$$\frac{B_1C_1 \cos(23)+C_2A_2 \cos(31)+A_3B_3 \cos(12)}{\sin(123)}$$
$$+p_1+p_2+p_3=a+b+c,$$

where p_1, p_2, p_3 are the pitches of the three screws, and a, b, c the pitches of the principal screws of the system. The author derived his results by the method of quaternion arrays, and showed that many relations similar to that given above may be deduced for screw-systems of any order.—Mr. John **Fraser** reduced the equation of a quartic surface possessing a nodal conic to the sum of squares of the five Jacobian quadrics of the systems of quadrics which pass through the conic, and which have double contact with the quartic surface. He gave explicitly the equations of the quadrics, and showed that the same method was applicable in the case of binodal quartic curves.

PARIS.

Academy of Sciences, January 4.—M. Mascart in the chair.—Researches on the emission of water vapour by plants and on their spontaneous desiccation: M. **Berthelot.** The roots and leaves of the plant investigated were first air-dried separately at the ordinary temperature, the temperature and hygrometric state varying during the experiment. After about eight days equilibrium was established, when the plants were further dried at 110°. A further loss of water was measured.—Proof of an experimental law given by M. Parenty on the flow of gases through orifices: J. **Boussinesq.**—The notion of work applied to the magnetisation of crystals: Pierre **Weiss.**—On osmosis: A. **Guillemin.** Adopting the theory of Halley, and the idea of the existence of a tension of expansibility, increasing with the depth below the free surface, the law of osmotic equilibrium takes the form that osmotic equilibrium exists when the tension of expansibility is the same on each side of the semi-permeable wall.—On the absolute value of the magnetic elements on January 1: Th. **Moureaux.** The absolute values and secular variation are given for the Observatory of Val-Joyeux, latitude 48° 49′ 16″ N., longitude 0° 10′ 23″ W.—On the stability of the direction of magnetisation in some volcanic rocks: Pierre **David.** It has been previously shown that some volcanic rocks possess a permanent magnetisation, which is probably that of the direction of the earth's field at the time when the rock solidified. This view has been confirmed by the examination of pieces of volcanic rocks taken from buildings dating from the Roman period. The inclination of all the pieces examined is identical, but the declination is variable.—On the decrease of temperature with height in the neighbourhood of Paris,

from five years' observations: Teisserenc **de Bort.** A summary of results obtained from experiments with captive balloons at heights varying from 500 to 14,000 metres.—Differential characters of the physiological radiations according as their origin is muscular or nervous: Augustin **Charpentier.** The rays emitted by muscle appear to be identical with the *n*-rays of Blondlot, but those emitted by nerves differ from these in that they are partially arrested by aluminium.—On the phosphoric esters of glycerin: P. **Carré.**—The retrogradation and coagulation of starch: L. **Maquenne,** A. **Fernbach** and J. **Wolff.**—The use of sodium sulphide as an indicator in the estimation of glucose by Fehling's solution: L. **Beulaygue.** Very exact results can be obtained in sugar titrations by the use of spots of sodium sulphide on filter paper as an indicator.—The ablation of the parathyroids in birds: MM. **Doyon** and A. **Jouty.**—The selection of small differences which present the characters with continuous variations: Georges **Coutagne.**—On the double secreting apparatus of Dipteryx: Édouard **Heckel** and H. Jacob **de Cordemoy.**—On polymorphic transformations: M. **Wallerant.**—On the geology of the Alps: Émile **Haug.**—Contribution to the knowledge of the Lutecian formations of Senegal: Stanislas **Meunier.** The material collected by M. Friry confirms the view that there was a large Eocene sea in Africa, and also tends to show that there was direct marine communication between Senegal and Egypt.—On a substitute for ligatures in surgery: M. **Wassilieff.**

DIARY OF SOCIETIES.

THURSDAY, JANUARY 14.

INSTITUTION OF ELECTRICAL ENGINEERS, at 8.—The City and South London Railway; Working Results of the Three Wire System applied to Traction, &c.: P. V. McMahon. (Adjourned discussion.)—On the Magnetic Dispersion in Induction Motors, and its Influence on the Design of these Machines: Dr. Hans Behn-Eschenburg.

ROYAL INSTITUTION, at 5.—The Flora of the Ocean: G. R. M. Murray F.R.S.

MATHEMATICAL SOCIETY, at 5.30.—On Various Systems of Piling: Prof. J. D. Everett.—The Solution of Partial Differential Equations by Means of Definite Integrals:

$$\frac{\partial^2 V}{\partial x_1^2}+\frac{\partial^2 V}{\partial x_2^2}+\ldots+\frac{\partial^2 V}{\partial x_n^2}=0:$$

H. Bateman.—On the Notion of Lines of Curvature in the Theory of Surfaces: Dr. G. Prasad.—On Groups of Order $p^\alpha q^\beta$: Prof. W. Burnside.—Electric Radiation from Conductors: H. M. Macdonald.—Open Sets of Points and the Theory of Content: Dr. W. H. Young.

SOCIETY OF ARTS, at 4.30.—The Presidency of Bombay: Sir William Lee-Warner, K.C.S.I.

FRIDAY, JANUARY 15.

ROYAL INSTITUTION, at 9.—Shadows: Lord Rayleigh.

INSTITUTION OF MECHANICAL ENGINEERS, at 8.—Sixth Report to the Alloys Research Committee on the Tempering of Steel: the late Sir William C. Roberts-Austen, K.C.B., F.R.S., and Prof. William Gowland.

INSTITUTION OF CIVIL ENGINEERS, at 8.—Pumping and Disposal of Sewage at York: A. D. Creer.

PUBLIC SCHOOL SCIENCE MASTERS' ASSOCIATION, at 1.45.—The Possibility of Fusing the Mathematical and Science Teaching of Public Schools: R. E. Thwaites.—Science in the Certificate Examination: W. A. Shenstone, F.R.S., and M. D. Hill.—Nature Study: O. H. Latter.

SATURDAY, JANUARY 16.

ROYAL INSTITUTION, at 3.—British Folk Song: J. A. F. Maitland.

TUESDAY, JANUARY 19.

ROYAL INSTITUTION, at 5.—The Development of Animals: Prof. L. C. Miall, F.R.S.

ROYAL STATISTICAL SOCIETY, at 5.

ZOOLOGICAL SOCIETY, at 8.30.—A Monograph of the Coleoptera of the Genus Hipporhinus: Guy A. K. Marshall.—On Proposed Additions to the Accepted Systematic Characters of Certain Mammals: Dr. Walter Kidd.—Some Observations on the Skull of the Giraffe: Dr. W. G. Ridewood.

SOCIETY OF ARTS, at 8.—Celtic Ornament: George Coffey.

INSTITUTION OF CIVIL ENGINEERS, at 8.—Discussion of Paper on the Electrical Re-construction of the South London Tramways on the Conduit System: A. Millar.—To be followed by: The Sanding-up of Tidal Harbours: A. E. Carey.

WEDNESDAY, JANUARY 20.

ROYAL METEOROLOGICAL SOCIETY, at 7.30.—Presidential Address, The Present State of Ocean Meteorology: Captain D. Wilson-Barker.

ROYAL MICROSCOPICAL SOCIETY, at 8.—Presidential Address, On the Evolution of Vertebrate Animals in Time: Dr. H. Woodward.

GEOLOGICAL SOCIETY, at 8.—On the Jaws of Ptychodus from the Chalk: Dr. A. Smith Woodward, F.R.S.—On the Igneous Rocks of Spring Cove, near Weston-super-Mare: W. S. Boulton.

CHEMICAL SOCIETY, at 5.30.—Optically Active Asymmetric Nitrogen Compounds *d*- and *l*-phenylmethylethylbenzylammonium Salts: H. O. Jones.—The Chemical Reactions of Nickel Carbonyl, Part I., Reactions with the Halogens, &c.: J. Dewar and H. O. Jones.—The Chemical Reactions of Nickel Carbonyl, Part II., Reaction with Aromatic Hydrocarbons in Presence of Aluminium Chloride. Synthesis of Aldehydes and Anthracene Derivatives: J. Dewar and H. O. Jones.—A Microscopical Method of Determining Molecular Weights: G. Barger.—*o*-Nitrobenzoylacetic Acid: E. R. Needham and W. H. Perkin, jun.—The *cis*- and *trans*-Modifications of αα'-Trimethylglutaconic Acid: W. H. Perkin, jun., and Miss A. E. Smith.—The Influence of Nuclear Substitution on the Rate of Oxidation of the Side-chain, I., Oxidation of the Mono- and Di-chlorotoluenes: J. B. Cohen and J. Miller. (1) A Simple Thermostat for Use in Connection with the Refractometric Examination of Oils and Fats. (2) The Interdependence of the Physical and Chemical Criteria in the Analysis of Butter-fat: T. E. Thorpe.—The Condensation of Furfuraldehyde with Sodium Succinate: A. W. Titherley and J. F. Spencer.

ENTOMOLOGICAL SOCIETY, at 8.—Annual Meeting.—The President, Prof. E. B. Poulton, F.R.S., will deliver an Address.

SOCIETY OF ARTS, at 8.—Organ Design: Thomas Casson.

THURSDAY, JANUARY 21.

ROYAL INSTITUTION, at 5.—The Flora of the Ocean: G. R. M. Murray, F.R.S.

LINNEAN SOCIETY, at 8.—An Account of a Plankton Expedition to the Bay of Biscay in H.M.S. *Research* in 1900: Dr. H. G. Fowler.—The Crustacea obtained by Dr. G. H. Fowler in the Biscayan Plankton: Rev. T. R. R. Stebbing, F.R.S.

FRIDAY, JANUARY 22.

ROYAL INSTITUTION, at 9.—Spectroscopic Studies of Astrophysical Problems at Stonyhurst College Observatory: Rev. Walter Sidgreaves, S.J.

PHYSICAL SOCIETY, at 5.—The Photographic Action of Radium Rays: S. Skinner.—Astigmatic Aberration: W. Bennett.—Some New Cases of Interference and Diffraction: Prof. R. W. Wood.—Exhibition of Instruments by Messrs. Crompton and Co.

SATURDAY, JANUARY 23.

ROYAL INSTITUTION, at 3.—British Folk Song: J. A. F. Maitland.

MATHEMATICAL ASSOCIATION, at 2.—Annual Meeting.—Models of Regular and Semi-regular Solids, including the four "polyèdres étoilés" of Poinsot, exhibited by Mr. E. M. Langley.—An Account of a Recent Discussion on the Possibility of Fusion of the Teaching of Mathematics and Science: C. S. Jackson.—A Geometrical Note: J. C. Palmer.—Advanced School Courses of Mathematics: C. A. Rumsey.

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