THURSDAY, JULY 2, 1891.

CRYSTALLOGRAPHY.

Elements of Crystallography for Students of Chemistry, Physics, and Mineralogy. By George Huntingdon Williams, Ph.D., Associate Professor in the Johns Hopkins University. Second Edition, Revised, pp. 246, with 383 Woodcuts and 2 Plates. (London: Macmillan and Co., 1890.)

THE position which crystallography ought to occupy in a scheme of scientific education is far from being generally recognized. Every day the importance of this branch of science, not only to the mineralogist and geologist, but also to the physicist and chemist, is becoming more deeply felt; and yet, as a general rule, the systematic study of crystallography is left quite unprovided for in our schools and Universities.

If we take any standard treatise on physics, we shall find that the subject of the measurement and calculation of crystal forms is almost, if not entirely ignored; and though it is, of course, absolutely impossible to discuss optical and other physical phenomena without reference to the wonderfully suggestive relations which exist between the properties resulting from internal molecular structures, and the crystalline forms which are the "outward and visible sign" of such molecular structure, yet the references are usually vague and, not unfrequently, misleading. In confirmation of this statement, it may be mentioned that in a very widely-used treatise on physics—one that has passed through many editions in this and other countries—there is a hopeless confusion between the terms "hemihedrism" and "hemimorphism" in the account which is given of the remarkable phenomena of pyro-electricity.

Nor, as a rule, have chemists dealt more adequately with the subject of crystallography than their brethren the physicists. In many chemical treatises we find such terms as pyramidal, prismatic, octahedral, rhomboidal, &c., employed so loosely as not to give the student the faintest idea of the real symmetry of the forms which are referred to. This neglect of crystallography by chemists is seen to be the more serious when we remember two important circumstances—first, that crystallization is often the only means which chemists possess of isolating and readily distinguishing many bodies; and secondly, that new substances are being continually formed by the chemist, the study of some of which may throw new and important light upon crystallographic principles.

Mr. Fletcher, in a very suggestive address to the Mineralogical Society, has justly remarked:—

"Hitherto, at least, the chemists of this country have been too content, either to leave the crystalline forms of their artificial products undetermined, or to impose the task of their determination on the already sufficiently occupied mineralogist. It seems obvious that in a satisfactory system of education every chemist should be taught how to measure and describe the crystalline characters of the products which it is his fate to ca l into existence. . . . A knowledge of the elements of crystallography, including the mechanics of crystal-measurement, ought to be made a *sine quâ non* for a degree in chemistry at every University."

The consequence of this neglect of crystallography by physicists and chemists has been that the teaching of crystallography has fallen almost entirely into the hands of mineralogists and geologists. But there is no more reason why every book on mineralogy should commence with a crystallographic treatise, than that it should include dissertations on refraction or articles on chemical analysis. "Crystallography should be taught as a special subject," and the student who, after his training in physics and chemistry, takes up the subject of mineralogy, ought to know at least as much of the measurement and symmetry of crystal forms, as he does of the effects of various media on different kinds of radiant energy, or the reactions of the several bases and acids.

It would be easy to show that, much as mineralogists have done for the study of crystallography, the latter science would have been developed more logically, and perhaps more rapidly, if the illustrations of the phenomena of crystallization had not been so exclusively sought among natural products. We find not a few examples in the terminology of the science of the effects of this one-sided growth of crystallography.

Crystallography is based upon purely mathematical considerations, and the study of the principles of crystal-measurement, the discussion of crystal-symmetry, and the calculation of fundamental forms, ought clearly to be one of the first branches of applied mathematics to be taken up by the student of physics; thus the study of crystallography should certainly precede that of physical optics. If this course were followed, the student of chemistry and mineralogy would come to the teachers of those sciences with such an amount of preliminary information as would enable him to profit by their instructions.

In the work now before us, Dr. Williams fully recognizes the importance of the principles for which we have been contending, and has endeavoured to supply English-speaking students with a short and clear treatise on the principles of crystallographic science. It is certainly remarkable that the countrymen of Wollaston, Whewell, and Miller should have had to wait so long for a work of this character; though every student of the subject must gratefully remember the aid afforded by the admirable little primer prepared some years ago by Mr. Gurney, and published by the Society for Promoting Christian Knowledge.

Of Dr. Williams's qualifications for undertaking a work of this kind it is unnecessary to speak. His numerous original researches afford abundant evidence of his devotion to crystallographic study, and in the preparation of the work he has had the advice and assistance of one of the first crystallographers of the United States, Prof. S. L. Penfield, of New Haven.

In order to keep the work within the smallest possible limits, it has been restricted to geometrical crystallography, but otherwise the work has been modelled upon the same lines as Groth's standard work, "Physikalische Krystallographie." The plates and very numerous woodcuts afford the greatest possible aid to the reader, and the typography leaves nothing to be desired. In looking through this revised edition, we are struck with the almost entire absence of those typographical errors that so easily creep into a work of this kind, and which, though so obvious to an expert, often prove to be a source of infinite trouble to the beginner.

In dealing with the vexed question of crystallographic notation, we think Dr. Williams has exercised a very wise discretion. The simple and easily understood symbols of Naumann have been employed in the first instance, but in almost every case the corresponding symbol of Miller's system has been added in brackets. While all students of physics, chemistry, mineralogy, and geology ought to equip themselves with such an amount of crystallographic knowledge as may be derived from the study of this book, only a very small proportion of them are likely to be called upon to deal with the higher and more complicated problems of the science. The small minority of students who devote themselves to purely crystallographic researches may be fairly recommended to employ from the first the beautiful method of notation devised by Whewell and perfected by Miller; but it is more than doubtful if the student with a smaller amount of mathematical training would gain any real benefit from such a course. In an appendix, "on zones, projection, and the construction of crystal figures," the author of this work has indicated to such a beginner the nature of some of the methods of investigation which are pursued by more advanced students.

In any future edition of the work—and such, we feel sure, will certainly be called for—we think that the author would do wisely to add a table showing the symbols of the chief forms according to all the different systems of notation commonly employed. The student who turns to the classical memoirs of Des Cloizeaux, Mallard, Bertrand, and others of the French school of crystallography, would thus be enabled to avail himself of much valuable literature, which, owing to the employment of an unfamiliar notation, must otherwise remain a sealed book to him.

We have spoken regretfully at the outset of this notice of the general neglect of crystallographical studies; but we are compelled to admit that, for this neglect, crystallographers themselves are largely to blame. The confusion produced by numerous rival systems of notation is answerable for much of that feeling of despair among those who attempt to make themselves acquainted with the subject. If the time has not yet arrived when a uniform crystallographic language can be agreed upon, much might be accomplished if the plan adopted by the author of this work of giving in every case the symbols according to *two* systems were followed. This is already done in the *Zeitschrift für Krystallographie*, the *Neues Jahrbuch für Mineralogie*, &c., the Journals of the English and French Mineralogical Societies, and several other well-known periodicals. If a conference of the leading crystallographers of Germany, France, and England could be held to decide upon the order in which the axes should be taken in writing symbols and other similar arrangements which are purely conventional and arbitrary, we might hope to see much of the confusion removed that has so long been a bar to the progress of this most fascinating and important branch of science.

We feel assured that the simultaneous publication in this country and in America of so simple and at the same time so accurate a text-book of the subject as the work we are now considering will do much towards reviving and diffusing a taste for the study of crystallography The student who masters the contents of this little book will undoubtedly have much more to learn before he is competent to deal with all the higher problems of crystallographic science; but, however far his researches may be carried in the future—and this is, perhaps, the very highest praise we can give to the book—he will certainly have little, if anything, to *un*learn.

JOHN W. JUDD.

PHOTOGRAPHY IN COLOURS.

Photographie des Couleurs par la Méthode Interférentielle de M. Lippmann. By Alphonse Berget. (Paris: Gauthier-Villars et Fils, 1891.)

THIS interesting little *brochure* contains an account of the recent achievements in colour photography which have been made so widely known to the English public through the daily papers. Coming from the pen of an "attaché au Laboratoire des Recherches (Physique) de la Sorbonne," we may take this contribution as an authorized exposition of M. Lippmann's work, and as such it will be found useful by physicists, chemists, and photographers, as well as by the general reader who wishes to know the real state of the case concerning this important departure in photographic methods. In a short historical introduction the author calls attention to the previous photochromatic attempts by Seebeck in 1810, by Herschel in 1841, by Edmond Becquerel in 1848, by Niepce de St. Victor in 1851 to 1866, and by Poitevin in 1865. It is stated that these and all similar attempts were based upon purely chemical methods, the investigators seeking for some sensitive compound which would give chromatic impressions corresponding to the colours impinging on the film. M. Berget adds the important remark: "*a priori*, ce problème est irréalisable."

Chapters ii. to v. are devoted to elementary optical principles. Chapter ii. deals with vibratory movements and their propagation, wave-length and period, and sonorous waves. In the third chapter the phenomenon of interference is described and explained; in the fourth chapter we have sections on the luminiferous ether, the velocity of light, the decomposition of white light by a prism, and Fresnel's theory of the spectrum colours. The subject of complex colours, as distinguished from the pure colours of the spectrum, is also dealt with in this chapter, and is of special importance in connection with the colours of natural objects, to which the author devotes a short section. It is pointed out that the principle of superposition of vibrations holds good in optics as in acoustics, and that just in the same way that the diaphragm of a phonograph can take up and faithfully transmit the extremely complex system of superimposed aërial vibrations produced by the human voice, so the ether transmits the complex superimposed vibrations emanating from coloured objects. In connection with the history of the undulatory theory, the whole credit is given to Fresnel: "L'honneur de donner la première théorie rationelle de la lumière, en la considérant comme résultat d'un mouvement ondulatoire, était réservé à un savant français: Fresnel." We should like to have seen Thomas Young receive at least an honourable mention.

The subject of interference receives more detailed treatment in chapter v., the interference of direct and reflected waves, and the theory of Newton's rings, being specially dealt with. It is not till we come to the sixth chapter that we are introduced to the main subject of the *brochure*. The principle which guided M. Lippmann in his experiments is well and tersely given. Imagine a plane metallic mirror with its reflecting surface coated with a transparent, homogeneous film of a silver haloid in albumin or collodion. Supposing a coloured ray of definite wave-length to fall on such a film, the undulations would traverse the transparent sensitive film, and being reflected from the polished surface of the mirror, and meeting the incident waves, would produce interference. The space in front of the mirror would thus be occupied by parallel planes alternately light and dark, and separated by half wave-lengths, *i.e.* by spaces of 1/4,000,000 of a millimetre. There is therefore ample space, even within the thickness of the film, for several of these planes of interference. On development, the planes corresponding to the light intervals would alone give films of metallic silver, while the dark intervals would remain unaffected. On fixing, there would thus be left in the film a series of parallel films of metallic silver separated by half wave-lengths. Any pair of such films constitute a thin plate in the Newtonian sense, and will give by interference a colour corresponding to that which produced the original deposition of the films when viewed by reflected light.

To realize the foregoing principle experimentally, M. Lippmann has found it necessary to use dry films of collodion, or albumin, or gelatine sensitized by immersion, as in the old wet collodion process: emulsions are granular and opaque, and contain particles which are gross in comparison with the half wave-length of a spectrum colour, and cannot be used. Moreover, it has not been found practicable to coat the reflecting surface of the mirror directly with the sensitive film, because the free iodine tarnishes the silver and destroys its reflecting power. This difficulty has been surmounted by making the coated glass plate one side of a shallow trough with parallel sides filled with mercury, the coated side being inwards, and in close contact with the mercury. The conditions for reflection and interference are thus fulfilled. The image of the spectrum is focussed on a glass plate with a ground surface, which is temporarily fixed to the side of the cell or trough in the same position as that occupied by the sensitive plate, *i.e.* with the ground surface inwards. After focussing, the ground glass is removed, and the sensitive plate substituted for it in the position described.

The spectrum was produced by an electric arc light of 800 candle-power, and the time of exposure for the different parts of the spectrum was regulated by interposing cells with coloured solutions, beginning with a solution of helianthin which transmits only the red and yellow, then replacing this by a cell of potassium dichromate which transmits the red, yellow, and green, and then finally exposing for a few seconds without any screen, so as to impress the blue and violet. The whole time of exposure varies, according to the sensitiveness of the film, from half an hour to two hours. The details of development and fixing are given by M. Berget, and do not differ fundamentally from the ordinary methods. The finished image, *when dry*, shows the spectrum colours by reflected light with metallic brilliancy, and as the colours are purely optical, depending only on reflection and interference, they are permanent. As the author points out, it is certainly a marvellous tribute to the fidelity of the photographic method that a series of laminæ of metallic silver separated by intervals of only about 1/4,000,000 of a millimetre should retain their positions with optical accuracy during the processes of fixing and development.

There can be no doubt—as will be admitted by all who have seen the results—that M. Lippmann is to be congratulated on having made a most important advance in the methods of photochromy. How far his experiments go towards the realization of the great problem of photographing objects in their natural colours is a question quite distinct from his present achievement. M. Berget tells us that satisfactory reproductions of coloured glasses illuminated from behind by the electric light have been obtained, but this is only a very little step in the desired direction.

"Que reste-t-il à faire pour rendre *absolument usuel* le procédé photochromique de M. Lippmann?" There remains a great deal! Not the least of the requirements is a transparent sensitive film equally sensitive to every colour of the spectrum, and sufficiently sensitive as a whole to enable the impression to be secured with a moderate exposure, instead of 30 to 120 minutes. Till this is accomplished we are not much nearer the solution of the problem of photography in natural colours than we were before. M. Berget speaks hopefully of the prospects in this direction, and we wish every success to his anticipations. But it is no detraction from the merit of M. Lippmann's results if these have no immediate bearing on practical photographic processes. As a triumph of physical science these experiments will live.

"C'est aussi un triomphe pour la science française, car ce mode de reproduction des couleurs du spectre à l'aide des lames minces limitées par des plans d'argent constitue une matérialisation, réalisée par un savant français, de ces ondes lumineuses conçue pour le première fois par le puissant génie d'un autre Français illustre: j'ai nommé Augustin Fresnel."

With this patriotic outburst M. Berget concludes his pamphlet, and the compatriots of Niepce and Daguerre may well be gratified with this latest emanation from the physical laboratory of the Sorbonne.

R. MELDOLA.

OUR BOOK SHELF.

Geometry of Position. By R. H. Graham, Author of "Graphic and Analytic Statics." (London and New York: Macmillan and Co., 1891.)

THIS work essays to fill an existing want by providing an English text-book on the important subject of geometry of position in relation to graphical statics.

The author gives an introductory chapter on anharmonic pencils and ratios, followed by an interesting chapter on projective conics, and devotes the remainder of the book to the application of graphic methods to statical problems, including, amongst others, the discussion of Maxwell's theory of reciprocal figures.

The chapter on anharmonic pencils and ratios would have been considerably improved by the introduction, at the beginning, of more definitions and explanations of the nomenclature adopted. The proofs of Desargue's theorem and its converse, given on p. 3, are unduly compressed, considering the early stage at which they are introduced; and the student's preliminary difficulties will be increased by the fact that the enunciations have been given in succession, while there is nothing to indicate which is to be treated first.

In the chapter on reciprocal figures, we would suggest that the proof given of Theorem I., Art. 50, might with advantage have been dispensed with. In Art. 52 it is erroneously assumed that OB' is equal to force (1); this assumption mars a proof which would be otherwise good.

The work exhibits evidence of originality, and it is, perhaps, to be regretted that the proof-sheets have apparently been revised only by the author himself. Their revision by one who had no part in compiling them would probably have contributed to a better arrangement, and to the exclusion of much that is vague.

The carefully drawn diagrams of different problems contained in the book form admirable illustrations to the non-technical reader of the nature of the operations involved in the application of the graphical calculus, and of the character of the results obtained by it. They are the more welcome as such information is not readily available in English text-books, while in foreign treatises it is often developed in such minute detail as to make the foundations nearly inaccessible to the general reader.

A word of praise is due to the interesting collections of examples at the ends of the chapters, which are, it seems, mostly original, but partly drawn from sources not often laid under contribution in the ordinary text-books.

ALEX. LARMOR.

The Species of Epilobium occurring North of Mexico. By Dr. Trelease, Director of the Missouri Botanic Garden. From the Second Annual Report of the Garden, issued April 1891. 48 pages, 48 plates.

EPILOBIUM is not a very large genus, but is spread universally through the north temperate zone, both amongst the plains and mountains, and reappears in plenty in New Zealand. The species are very difficult of delimitation and definition, and great diversity of opinion has prevailed as to their number, and the validity of the characters which have been used to characterize species. It is evident, moreover, that many of them hybridize freely in nature. Passing over the earlier well-known writers, such as Pursh, Muhlenberg, Hooker, and Gray, in 1876 Barbey contributed a monograph of the Californian species to Brewer, Watson, and Gray's "Flora of California," and later published excellent figures of the new species which he there described. In 1884, Haussknecht published a monograph of the whole genus. Of the 38 species dealt with in Dr. Trelease's paper, 13 have been proposed by Haussknecht, 3 by Barbey, 4 by himself, and one by Parish, so that more than half the 38 have been lately described for the first time. Dr. Trelease describes fully all the species known in Temperate North America, gives an octavo plate of each of them, and a detailed account of their geographical distribution, citing the numbers of all the recent collectors. Of the 38 species only 9 extend their range beyond the American continent. The paper will be a very acceptable contribution to our knowledge of a difficult genus, and will no doubt be incorporated in the new "Flora of North America," of which the second volume is already published, and the first and third of which we anxiously wait for. J. G. B.

A Guide Book to Books. Edited by E. B. Sargant and Bernhard Wishaw. (London: Henry Frowde, 1891.)

THERE are so many books of all kinds that ordinary readers may be excused if they are sometimes at a loss as to the works which they ought to select for study. The editors of the present volume have come to the aid of such readers, and may be congratulated on the manner in which they have accomplished a useful but most troublesome task. They make no attempt, in a philosophical sense, to classify the various subjects with which authors have dealt; they simply take these subjects one after the other, in alphabetical order, and set down what seem to them the best books relating to each. Taking into account the amount of space at their disposal, they probably could not have chosen a plan that would have been more readily intelligible. Of course opinions will differ about the value of the works included in the several lists. Everyone who consults the volume will be of opinion that the editors have omitted some things which they ought to have noted, and that they have noted some things which they ought to have omitted. But there cannot but be a general agreement that, upon the whole, the selection has been made on sound principles, and that it is likely to be of real service to very many of those who may have occasion to refer to it. A large number of eminent writers have helped the editors, not only by drawing up lists of books, but by giving them much valuable advice.

Tasmanian Official Record, 1891. By R. M. Johnston, F.L.S. By Authority. Second Year of Issue. (Tasmania: William T. Strutt, Government Printer, Hobart, 1891.)

ANYONE who may wish to obtain information about Tasmania will be hard to please if he does not find what he wants in this elaborate volume. It begins with an account of the general physical outline of the island, and then we come to Tasmanian history, and to the Tasmanian constitution and government. After a chapter on Crown lands we are invited to consider the geology and mineral products of Tasmania, its flora and vegetable products, fauna and animal products, population, vital statistics, trade and interchange, accumulation, finance, production, law, crime, and protection, and "intellectual and social provision." The work is wound up with a view of the progress of Australasia, and a summary of general statistics. In the present issue some important additions have been made to the book as originally published, and by devoting attention to classification the editor has tried to "obviate any difficulties that might arise from the necessity of bringing together in one volume such a variety of subjects."

LETTERS TO THE EDITOR.

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

The Albert University.

PROF. LANKESTER, in the interesting letter published in NATURE for May 28 last (p. 76), expresses his desire to have "a genuine professorial University set on foot in London, not because it is London, but because University and King's Colleges are there, and respectfully petition Her Majesty to do for them what the monarch has done in past days for other Universities."

I have not seen the petition of the Colleges. But I have before me the draft charter adopted by their Councils, which I presume is intended to give effect to the prayer of the petition. I can hardly imagine that Prof. Lankester was acquainted with its contents when he penned the sentence which I have quoted.

If the Albert University is called into existence—and it seems very probable that its charter will be granted—it will be an institution very similar to what the University of London was in the early years of its existence, when it drew its candidates only from the so-called affiliated Colleges.

The charter commences by reciting "that it is expedient there should be constituted in and for the London district (defined as 'a radius of fifteen miles from Somerset House') a University . . . commending to its students systematic courses of teaching and methods of study." But "commending" is what we all do now.

The new University is to be of the federal type. Beginning with University and King's, "other Colleges may from time to time be admitted." This was inevitable, though my pointing out the fact made my friend Prof. Lankester somewhat angry.

Any medical school may be admitted which is recognized as efficient by any qualifying body under the Medical Acts. But while Colleges will have representatives on the Council, the medical schools will only have representatives on the Faculties.

Degrees may be granted apparently in any subject the Council please, subject to a regular course of study and examination. This will apparently admit theology, which is probably a desirable thing, provided it be unsectarian.

The powers to grant degrees are rather large, and deserve careful consideration. The London radius at once, as has been the case with the existing University, goes off into Imperial infinity in the provision that anyone who has been a resident student in any University in the Empire may count his time and examinations, except that a "final portion of the period of study" and the "final examination" shall be passed in the University.

There is an unlimited power to grant *ad eundem* degrees as well as honorary degrees at the discretion of the Council. Fellows of University and King's Colleges (a purely honorary distinction in itself) are indicated as fitting recipients, and also "past students of the said Colleges," a rather large door to open if in the future a degree is to have any meaning at all.

Power is taken to examine into the efficiency of schools or any academic institutions—work already in the hands of other Universities—and apparently the London radius again becomes infinite.

Independent University lecturers may be appointed.

The Council will consist of members appointed for five years by (1) the Crown (Lord President); (2) Convocation; (3) Colleges; (4) Colleges of Physicians and Surgeons; (5) Faculties. The Faculties are to be constituted (1) of teachers in the Colleges; (2) of examiners; (3) of persons who are or have been engaged in University teaching in London. The Boards of Studies are delegations from the Faculties, as they should be. All this is much on the lines sketched out in my own letter in NATURE.

A rather remarkable feature in the scheme is the creation of a Convocation of graduates. Whatever may be the function of this body in other Universities, it is somewhat surprising to meet with its existence in what professes to be a teaching University.

The examinations are to be conducted by examiners who are members of the respective faculties associated with external examiners; the teacher-examiner seems not to be insisted upon.

These are the essential elements of the proposed constitution. If it is asked what distinctive character the Albert University will possess which will mark it off from the existing University, or from that body as it might be conceivably reconstituted, I must confess that it seems to me to lie in a very small compass. Notwithstanding the use of the ambiguous word "commending," when one would have expected "prescribing," I take it for granted that the essential feature in the whole scheme is the enforcement upon candidates for degrees of attendance upon a curriculum. But in the existing University, this is already required in the Faculty of Medicine. Prof. Huxley has further urged it in the Faculty of Science; and for my part I believe that the time has arrived when it might be demanded without difficulty. The prominence given to practical work in the science examinations has made it all but impossible for a candidate to acquit himself successfully who has not attended a competent course of instruction. To insist upon a curriculum would be now scarcely more than the practical recognition of this fact. The only real point of divergence is in the Faculty of Arts; about this I speak with some hesitation. It may be that the enforcement of a curriculum is desirable; I am not satisfied that in this faculty it is so, or at any rate absolutely essential, as I think it is in the Faculty of Science. With this exception I can see no net public gain in the new scheme to justify the creation of the cumbrous machinery of a new federal University.

Seeing that the existing University is a State institution in actual possession of the field, I think the public at large might have reasonably expected from the Senate some statesmanlike criticism, rising above the petty level of supposed self-interest in the very serious action which the Government is apparently about to take.

They content themselves, however, with a sort of half-sulky acquiescence in the scheme "so far as it proposes to confer on the petitioning Colleges the power of granting degrees in arts and science to students of the Colleges who have pursued their entire academic curriculum within the Colleges." The Senate, a little maliciously, proceeds to point out that "the petition of the Colleges lays great stress upon the paramount importance of close association of students and teacher-examiners, and of placing the power of granting degrees in the hands of those teachers who have instructed the candidates." It not unnaturally insists upon the inconsistency with this position of the proposal "to accept residence and examinations at other Universities," if only a final period of study, "which might be a short attendance at evening classes," be passed at the new University.

It also objects to the honorary and *ad eundem* degrees. But its criticism is even more destructive in regard to the Medical Schools. It is quite obvious that if the Medical Schools joined the Albert University, the teacher-examiner system would disappear, and the new and the old Universities would be simply competing agencies for doing the same kind of work in the same kind of way. The same argument applies more or less to the other faculties as soon as the number of constituent Colleges becomes numerous.

Yet so great is the magic of a phrase that the daily papers in reporting the proceedings in the Privy Council describe the scheme as that of a Teaching University. A University of the Scotch or German type may have some claim to that title; but no federal University can ever possess a valid one, for the simple reason that there will always be a morphological distinction between the Colleges which teach and the University which examines and grants degrees.

Prof. Lankester contended in his letter that the question whether University and King's Colleges should have a University Charter was a sort of private affair between them and the Government. But I do not think this view can be accepted. Whether we like degrees or whether we do not, they have a certain value in the eyes of the public. Personally, I have no objection to the multiplication of Universities, if each has a proper geographical area assigned to it. But the multiplication of Universities in the same place seems to me a great evil. It cannot be assented to without the necessity being shown to be overwhelming. And in the present case it appears to me that it cannot be so shown. If the existing University is so injurious to the best interests of the higher education that another is imperatively demanded to do the work in which it fails, then it appears to me that two obvious points present themselves:—

(1) The new University should be free from the defects that attach to the old one. Prof. Lankester speaks of the "thraldom" of "the Imperial centralizing institution"; but when the matter comes to be looked into, the new institution also proposes to be Imperial and centralizing, and will be found to exercise the same or even greater thraldom on the individual teacher.

(2) If the old University is really doing mischief, it is the paramount duty of the supreme Government, whose creature it is, to reform it. The fact that the Senate and Convocation are at loggerheads how this is to be effected is really beside the question. When public opinion demanded the reform of the older Universities, new ones were not created alongside the unreformed old ones; but a Commission with executive powers effected the changes which were necessary. And for a similar procedure there is still time at Burlington Gardens.

W. T. THISELTON-DYER.

Royal Gardens, Kew, June 30.

The Holarctic Region.

REVIEWING the recently-published "Introduction to the Study of Mammals" by Prof. Flower and Mr. Lydekker, Prof. Lankester states (*supra*, p. 122) that "The authors of the present work mention Dr. Heilprin's opinion that the Palæarctic and Nearctic regions should be united and called the Holarctic region. But they do not adopt this opinion, nor refer to Huxley's proposal to term this same area Arctogæa," and so on. Now, in this last statement my good friend the reviewer, perhaps writing from memory, is mistaken. Had Prof. Huxley proposed to limit his "Arctogæa" to the Palæarctic and

Nearctic regions of Mr. Sclater and Mr. Wallace, I should certainly not have suggested to Prof. Heilprin a new name for that combination. Anyone looking to the passage (Proc. Zool. Soc., 1868, pp. 314, 315) in which Prof. Huxley defined his "Arctogæa"—a name to which, let me say, I have not the least objection—will see that it signifies that part of the world which is not "Notogæa," and therefore includes the Ethiopian and Indian regions of Mr. Sclater, whereas my "Holarctic" region expressly excludes them, and is therefore a very different thing from "Arctogæa" in its true sense.

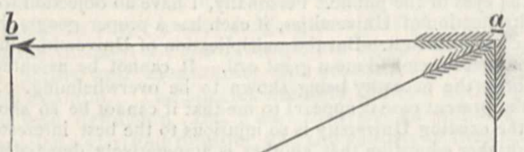
ALFRED NEWTON.

Magdalene College, Cambridge, June 12.

Force and Determinism.

IN your issue of March 12 (vol. xliii. p. 491), Dr. Oliver J. Lodge characterizes as "perfectly correct" the statement "that, although expenditure of energy is needed to increase the speed of matter, none is needed to alter its direction." I have looked in vain for some notice of this apparently strange doctrine in your subsequent issues, with the exception that Prof. C. Lloyd Morgan (April 16, p. 558) objects that the direction of motion cannot be changed by purely metaphysical means, or will-power. But passing over this rather important and interesting point with only the observation that Sir John Herschel thought differently—thought, in fact, that "without the power to make *some* material disposition, to originate *some* movement, or to change, at least temporarily, the amount of dynamical force appropriate to one or more material molecules, the mechanical results of human or animal volition are inconceivable" (*Fortnightly Review*, July 1, 1865, vol. i. p. 439)—I desire to call a moment's attention to the first statement alluded to.

Dr. Lodge admits that "expenditure of energy is needed to ncrease the speed of matter." But, as a matter of fact, is it not very difficult, if not indeed practically impossible, to change the direction of a moving body without affecting its speed? "A force at right angles to motion does no work," says Dr. Lodge. Let us examine this statement for a moment. Let a body be moving in the direction a to b with a speed sufficient to traverse the distance in one unit of time. Then let a force be applied to



the body at a, at right angles to the direction of its motion, sufficient, if acting alone, to carry the body to d in the same unit of time. By the composition of forces, the body, at the end of the unit of time, would, therefore, be found at c. But the distance ac is greater than ab; and as, by the interposition of a force at right angles to its motion, the body has thus traversed a greater distance in the same time, has not its speed, as a matter of fact, been increased? and is not this increase of speed actual work? and does not this work require actual energy to perform it?

EVAN MCLENNAN.

Brooklyn, Iowa, U.S.A., June 9.

I AM glad to see my statement called in question, and hoped that it would have aroused more antagonism than has yet been expressed; because I do believe that it has important psychological or metaphysical consequences, and should therefore either be repudiated by physicists or after due discussion be accepted by non-physicists.

With regard to the special objection raised by Mr. McLennan, it may be sufficient to remark that, in his diagram, ac is the line of motion, ad the direction of the force, and that ad is not at right angles to ac. His difficulty seems to be the one that some people always feel with regard to the use of infinitesimals in general. He must remember that his diagram will not apply to the case of curvilinear motion unless the impulses contemplated are momentary and infinitesimal.

OLIVER J. LODGE.

The Scorpions at the Zoo.

YOUR contributor of the notice, published in NATURE on June 18 (p. 163), on the contents of the Insect-house at the Zoo, who laments the unfortunate circumstance that the scorpions there in captivity remain unnamed, may be glad to learn that these creatures may be easily identified, and, with a little dexterity, fearlessly handled.

During a recent visit to this house, the keeper obligingly showed me the two Egyptian scorpions, one of which—the black individual with the thick tail—was easily recognizable as *Prionurus crassicauda*, Oliv., a tolerably common North African and Syrian form.

To the other, however, I could not so readily assign a name; partly owing to its partial concealment, and partly to the fact that critical inspection is required to distinguish between the species of the genus to which it belongs. It appeared, nevertheless, to be a specimen of *Buthus europæus*, Linn., the commonest of all the Mediterranean scorpions. But my attempt to verify this point by closer examination was immediately frustrated by the keeper; who, evidently thinking that I was qualifying for incarceration in Bedlam, hastily interposed when I stretched out my hand to pick up the noxious animal.

The third scorpion I did not see; but doubtless it is a specimen of one of the species of *Euscorpius*. This, too, can be easily named, no doubt; but it will be necessary to handle the specimen in order to be certain on the point.

I would warn your contributor not to be too sanguine of the permanence of the amicable relations that appear at present to be established between these three Arthropods. If the supply of dead mice runs short, there will, of a surety, soon remain nothing but a few fragments of *Euscorpius*. Such thoroughgoing cannibals are not likely to be squeamish, when a member of another genus is before them.

In conclusion, some of your readers may be interested to know that the spider referred to as *Lycosa portosantana*—which, by the way, should be styled *Tarantula maderiana*—is a very near ally of the famous and historical Tarantula of Italy; and that the hairy Brazilian monster, the so-called Mygale, who squats under a broken flower-pot in the next cage, has no more claim to the title Tarantula than any other Arachnoid with a formidable aspect.

R. I. POCOCK.

Natural History Museum, June 18.

Cetaceans in African Lakes.

WITH reference to Mr. Sclater's inquiry (NATURE, June 11, p. 124) as to the occurrence of porpoises in the Victoria Nyanza, the following extract from Bernier, who wrote about 230 years ago, will probably prove of interest.

I may add that in another passage Bernier gives further information regarding the sources of the Nile.

It would seem from the passage quoted that the occurrence of a Cetacean in the Abyssinian sources of the Nile was probably known to early travellers, and, like the occurrence of diamonds in other parts of Africa, cannot be regarded as a new discovery.

Science and Art Museum, Dublin, June 22. V. BALL.

An Armenian named Murat and a Mogul who came as ambassadors from the Christian King of Ethiopia (*i.e.* Abyssinia) to Aurungzeb shortly after his accession to the Mogul Empire, in 1659, told the French physician Bernier, who then resided at the Mogul's court, "that the Nile had its origin in the countrey of *Agaus*, that it issued out of the earth by two springs bubbling up near to one another, which did form a little lake of about 30 or 40 paces long; that, coming out of this lake, it did make a considerable river; and from space to space it received small rivers increasing it. They added that it went on circling and making as 'twere a great isle, and that afterwards it tumbled down from steep rocks into a great lake in which there were divers fruitful isles, store of crocodiles, and (*which would be remarkable enough if true*) *abundance of sea calves, that have no other vent, &c., than that by which they take in their food,* this lake being in the country of Dambea, three small days' journey from Gundar and four or five days' journey from the source of the Nile, &c., &c." ("The History of the Empire of the Mogul," English translation of 1684, p. 44).

ON SOME POINTS IN THE EARLY HISTORY OF ASTRONOMY.[1]

V.

IT is imperative to be perfectly definite and clear on the question of the amplitudes above 26° at Thebes. Any amplitude within 26° means that up to that point the sun at sunrise or sunset could be observed some day or days of the year—once only in the year if the amplitude is exactly at the maximum, twice if the maximum is not reached. But in the case of these temples with greater amplitudes than 26°, it is quite clear that they can have had nothing to do with the sun. Is there, then, any additional line of evidence that the Egyptians used these temples to observe the stars? Here a very interesting question comes in; a temple built at one period to observe a star could not go on for ever serving its purpose, for the reason that the declination of the star must change by precession. Therefore a temple built with a particular amplitude to observe a particular star, useful for one period would be useless for another.

We have here possibly a means of testing whether or not any of these temples were used to observe the stars. In those very early days, 3000 or 4000 years B.C., we must assume that the people who observed the stars had not the slightest idea of these possible precessional changes; they imagined, that they were just as safe in directing a temple to a star as they were in directing a temple to the sun. But with a star changing its declination in an average way, the *same* temple could not be used to observe the same star for more than 200 or 300 years; so that at the end of that time, if they still wished to observe that particular star, they must either change the axis of the old temple, or build a new one.

As a matter of fact, we find that the axes of the temples have been changed and have been freely changed; that there has been a great deal of work done on many of these temples which are not oriented to the sun, in order to give them a twist.

Once a solar temple a solar temple for thousands of years; once a star temple only *that* star temple for something like 300 years, so that the conditions were entirely changed.

We get cases in which the axis of a temple has had its direction changed, and others in which, where it has been difficult or impossible to make the change in a temple, the change of amplitude has been met by putting up a new temple altogether. We are justified in considering such temples as a series in which instead of changing the orientation of a pre-existing temple, a new temple has been built to meet the new condition of things. That, I think, is a suggestion which we are justified in making to Egyptologists on astronomical grounds.

We cannot, of course, make it with absolute certainty, for the reason that in the case of most of these temples the best Egyptologists cannot give us the most precious piece of information which we require from the astronomical point of view. That is the date of the *foundation* of the temple. If in the case of these temples it were absolutely certain that each temple was built at a certain time with a certain orientation, the use of the precessional globe would tell us at once whether or not that temple was pointed to any particular star. Some other astronomical considerations may here come to our help. If the north polar distance of a star is increasing—that is, if it is increasing its distance from the north pole—its declination is being reduced, and the orientation of the temple would be gradually becoming more and more parallel to the equator; if the declination of the star be increasing, then the orientation of the temple would have had to be more and more north or south. The change in the orientation, therefore, could give us important information, and ultimately we might be able to determine what the name of that particular star was. At present the matter must remain more or less as a suggestion; but if anything like approximate dates can be given, then astronomy really may come to the rescue of the Egyptologist and archæologist generally, and repay that debt to which I have referred, which she owes to so many other sciences.

Although, however, these matters can be discussed in a way that will indicate that the inquiry is raised, I do not wish for one moment to speak of it as being settled, because the observations which have been made already in Egypt with regard to the orientation of these temples have not been made from such a very special point of view; and further some alteration in the amplitude would be made by the presence of even a low range of hills miles away from Thebes in the case of a star rising or setting pretty nearly north or south. No

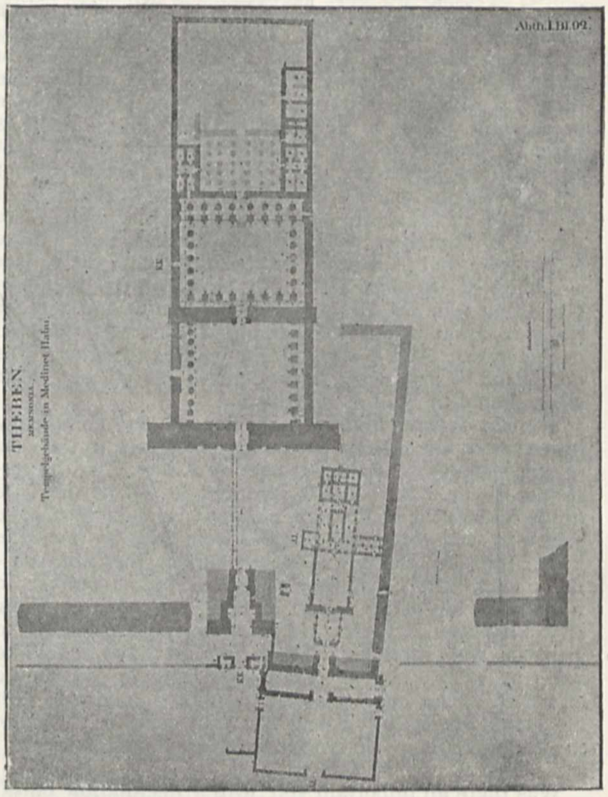


FIG. 14.—The two temples at Medinet Abou, showing the change in their orientation.

one would care to make the assertion with absolute definiteness until it was known whether or not the horizon in each case was interfered with by hills or any intervening objects—was or was not one, in fact, which might be regarded as a sea horizon from the point of observation; if there were impediments, the angular height of them must, of course, be exactly known.

To continue this observation and this kind of thought a little further, we will go back to Karnak generally. In the first place we have the magnificent solar temple.

Next we have two parallel temples, one of them a late addition to the solar temple itself, and another one parallel to it, each of them with an amplitude of 63°, one N. of E., the other S. of W. We have then two parallel temples *at right angles* to the solar temple at Karnak. We have also a temple, with an azimuth of 68° N. of E., and one, probably older still, with an ampli-

[1] Continued from p. 110.

tude of 70° or 71° N. of E.; both these temples face northerly, and nearly in the same direction. Near the last temple we have the ruins of another one at right angles to it, and this points to the westward amplitude 19° N. of W. We may assume from the plan of the ruins that the Naos is at the east end of the temple, therefore the chief pylon would have been to the west, and therefore the axis will be in that direction. In the row of sphinxes, a double row connecting the temples of Maut and Karnak, the line is absolutely complete as far as their bases are concerned, with the exception of two where there is a gap, and that gap is exactly in the axis of this temple prolonged. Here is another instance of the rights of the line of sight of a temple being strictly preserved.

The Egyptians have been accused of hating every regular figure, and even in the boundary walls of the temple of Ammon there are two obtuse angles. Round the Maut temple we also have walls, and there again this hatred of similarity seems to come out, for we have one obtuse and one acute angle. But if we examine the thing a little carefully, we find that there is a good deal of method in this apparent irregularity. The wall of the temple of Ammon is parallel to the face of the temple or at right angles to its length. One wall of Maut is perfectly parallel to the face of the temple or at right angles to the sphinxes. And the reason that we do not get right angles at one end of the wall is that the walls of the temple at Maut are parallel to the chief wall of the temple of Ammon. Surely it must be that, before these walls were built, it was understood that there was a combined worship, that they stood or fell together. One thing was not attempted in one temple and another thing in another, but the worship of each was reflected in the other. And if this be true you see that there was no hatred of symmetry, but a definite reason why these walls should be built as they were.

We can depend, and no doubt depend very completely indeed upon the labours of the Egyptologists, in the case of the temples of Rameses and of Khons. No Egyptologist so far, I believe, has ventured to tell us the date of the foundation of Karnak, but what Egyptologists have stated is that those two temples were built by the same king; their architecture is exactly similar, they are parallel to each other, and they altogether bear reference to apparently the same period of Egyptian history. Now that king was Rameses III., and the year according to Brugsch was 1200 B.C. Here then we have a definite basis of work. There is a temple with an amplitude of 63° N. of E., built 1200 B.C.; there is a temple with an amplitude of 63° S. of W., built 1200 B.C. From these amplitudes we determine as before the declinations; they come out 53° N. and 53° S.

Was there an important star with a declination of 53° N., was there another with a declination of 53° S. in the year 1200 B.C.? There *were* two important stars, one with a declination of 53° N. and another of 53° S. at that time. The north star was γ Draconis, the south star was Canopus. This strengthens the view that there was really some astronomical object in the plan and direction of these temples.

Thus, at the time when these two temples were stated to have been built, each *might have been used* to observe one the rising, the other the setting, of an important star. We have long ago seen that so far the Egyptians, like the Babylonians at a later date, only had an idea of observing a heavenly body and the position of other bodies in relation to it, so long as it was rising or setting, so that it was absolutely essential that the body which they were to observe should rise and set. You know perfectly well that in London there are many stars which neither rise nor set. The latitude of London being 51°, the elevation of the pole therefore is 51°, and from the pole to the north point of the horizon being 51°: of course any star which lies at that distance from the pole cannot set, but sweeps round without touching the horizon at all. The latitude of Thebes being 25°, the distance from the pole to the horizon is much smaller, and so the number of stars which do not rise and set is much smaller. The stars which did not rise or set were stars which were moving very slowly and the stars which rose most to the north and most to the south were those bodies which were moving most slowly while they yet rose or set. Can this slow rate of motion have had anything to do with such stars being selected for observation, the brightest star to the north, most slowly moving, the brightest star to the south most slowly moving? It is possible that observations of these stars might have been made in such a way that at the beginning of the evening the particular position of γ Draconis might have been noted with regard to the pole star, if there were no other reason; and seeing that the Egyptians thoroughly knew the length of the night and of the day in the different portions of the year, they could at once the moment they got the starting point of the rising of this star practically use the circle of the stars round the north pole as the dial of a sort of celestial clock. May not this really have been the clock with which they have been credited? However long or short the day, the star which was at first above the pole star, after it had got round so that it was on a level with it, would have gone through a quarter of its revolution.

So much then for the possible use of the temples built by Rameses III. in the year 1200 B.C. It has already been pointed out that although we have in one an amplitude of 63° N. of E. we have other temples with amplitudes of 68° N. of E. and 71° N. of E. Everybody agrees that the temple, with amplitude 63° N. of E., was built 1200 years B.C. I have shown that that temple could have observed the most northerly star which did not set. May it not have been that the 68° temple and the 71° temple were temples built to observe the same star *before* this one was built, because we know they could not have observed the star *after* this one was built, since γ Draconis was decreasing its declination, therefore in previous times its declination would have been *higher*, and the amplitude therefore of a temple to observe it would have been greater.

Looking back to the German tables and other calculations, we find that with an amplitude of 68° we get a declination of 56°, and the same tables tell us that that declination was the declination of the same star γ Draconis 2000 years B.C. It does look as if in all probability we are dealing with a series of temples not twisted but built in different places.

Can we consider that the temple with an amplitude of 71° might have been used to observe that same star long before the temples were built with amplitudes of 68° and 63°? The amplitude of 71° gives us a declination of 58°, we then find the year in which that same star γ Draconis had that declination to have been about 3000 years B.C. So that it is not impossible that temple was built first of all to observe γ Draconis 3000 years B.C., that after a time the star changed its declination so much that another temple became necessary, and 1000 years afterwards the change again became large, and still another temple was built to observe it. The three temples may form one series.

The discussion is a little difficult because the orientation is very far towards the south and north, and therefore a hill a few miles off would make a difference of 2° or 3° in the orientation of the temple, and as yet we have no observations that throw light on this point.

We have then at Thebes alone three converging lines of evidence which all go to strengthen the view that these temples were really—whatever else they might have been—usable as solar and stellar observatories. The difference being of course that in the case of the solar temple no large change of amplitude was necessary, but that in the case of every stellar temple after a lapse of a certain number of years depending upon the position of the star, the temple must be twisted round if it were wished to continue to make observations of the same star.

That raises an interesting question by the way. Long after the temple had been used for observation of a particular star, long after that temple line was blocked by extended building, if the horizon of these temples was left open it looks very much as if when another bright star came along it was laid hold of for a new set of observations. However that may be, it is rendered extremely probable, by the considerations I have brought before you, that the Egyptians 3000 years B.C. had been rendered practically conversant with the result of the precession of the equinoxes by the fact that they had to rebuild and alter their temples from time to time because the stars changed their declination. If that be confirmed by subsequent investigations, it will show that these Egyptians possessed a very much more profound knowledge of astronomy than they have received credit for, because it is stated that the precession of the equinoxes was discovered by Hipparchus. It looks as if the precession of the equinoxes was probably published by Hipparchus as the result of an examination of the untold wealth of Egyptian astronomical observations which has been unfortunately lost to the world.

This question of orientation is after all one which survives among ourselves. All our churches are more or less oriented, which is a remnant of old sun worship, and the church is not always oriented exactly to the east, but so that the light of the sunrising upon the Saint's day to whom the church is dedicated may be thrown along the chancel.

It has long been known that Stonehenge is oriented to the rising of the sun at the summer solstice. Its amplitude instead of being 26° is 40°; with a latitude of 51°, the 26° azimuth of Thebes is represented by an azimuth of 40° at Stonehenge.

The first of January is very near the winter solstice, but is not quite the winter solstice. If you look up the old records of the races that lived 2000 or 3000 years B.C., you will find that the different races began their year at different times, and even that the same race at different times began their year differently; the choice lay among the equinoxes and the solstices, and seeing that one of the very oldest temples at Thebes is oriented to sunset at the summer solstice we should not be at all surprised if investigation shows that when that temple was built more than 3000 years B.C., the Egyptian year really began in what we should call our summer. We have ample evidence of this. And I think there is little doubt that when Stonehenge was built it certainly was built by people who began their year with the summer solstice, which you will remember is the time of the year in which in many countries it is the habit still to light fires upon hills and so on.

The next point is, what was probably the use made of these temples besides determining the length of the year and regulating so far as they could the seasonal changes, the times of the solstices, the times of the equinoxes, and the various celestial phenomena?

We understand that in the very beginning of observations in all countries, the moment man began to observe anything, we saw that he began to observe the stars, and the moment men began to talk about anything they had seen they must have started by in some way or other defining the particular stars they meant.

They would obviously talk first of the brightest stars, and separate them from the dimmest ones; they would then discuss the stars which never set, and separate them from those which did rise and set; then they would take the most striking configurations, whether large or small; they would choose out the constellation of Orion or the Great Bear, and for small groups the Pleiades. These would attract attention, and be named before anything else. Then later on it would be imperative in order to connect their solar with their stellar observations that they should name the stars which lay along the sun's path in the heavens. They would confine their attention to a belt round the equator rather than consider the configuration of stars half-way between the equator and north pole. In all countries—India, China, Babylonia, Chaldæa, Egypt—they had a sort of girdle round the heavens, called by different names in different countries, and the use of this girdle of stars, which sometimes consisted of twenty-eight stations, sometimes of twenty-seven, and sometimes of only ten, was to enable them to define the place of the moon or of any of the planets in relation to any of these stars. That condition of things, that stage of thought, is brought well before us in the Jewish Scriptures.

In the Book of Job we read, "Canst thou bind the sweet influences of Pleiades, or loose the bands of Orion? Canst thou bring forth Mazzaroth in his season? or canst thou guide Arcturus with his sons?"

Here we have the difficulty which has met everybody in going back into these old records, because there was no absolute necessity for a common language at the time; it was open to everyone to call the stars any name they chose in any country, therefore it is difficult for scholars to find out what particular stars or constellations were meant by any particular words. In the revised version, Arcturus has given place to the Bear with its train, and even our most distinguished scholars do not know what Mazzaroth means. I wrote to Prof. Robertson Smith the other day to ask him to give us the benefit of his great knowledge, and he says that Mazzaroth is probably that band of stars round the ecliptic or round the equator to which I have referred, but he will only commit himself to the statement that it is a probable enough conjecture; other people believe that it was a reference to the Milky Way.

I mention this to show you how very difficult this inquiry really is. The "seven stars" undoubtedly mean the Pleiades and not the Great Bear. Among the brighter stars, Arcturus, the Pleiades, &c., are referred to by Homer and still earlier writers. So far as Egyptian and Chinese astronomy goes, practically the first reference to a constellation appears in Egypt with reference to the equinox which happened 3285 years B.C., and in China with reference to the Pleiades in the equinox of 2357 B.C.

In observing stars nowadays, we use a transit circle which is carried round by the earth so as to pick up the stars in different circles round the axis of the earth prolonged, and by altering the inclination of the telescope of this instrument we can first get a circle of one declination and then a circle of another.

The Egyptians did not usually employ meridian observations. Did the Egyptians make star maps? They certainly did. In the temple of Denderah, which is a comparatively modern temple, there is a very precious series of records which is certainly not at all modern. It represents a good many of the Egyptian constellations. The central part was in all probability the zenith point of Denderah itself, and at a certain distance from the centre point we have the zodiac represented excentrically. The constellations round the edge are those nearest the horizon; the central ones are those nearest the north pole; instead of having the Great Bear, we have the constellation of the Thigh, representing the well-known seven stars; in addition we have the constellation Hippopotamus, which has now entirely disappeared. There is also a Babylonian zodiac, which will show you that, although Babylonia and Egypt were adjacent countries, yet that they had a perfectly different set of constellations. Our present constellations came not from Egyptian times, but from much later—from Greek times. It is almost impossible to hope to recover the names of the constellations used by people earlier than the Greeks, but still much is to be hoped from the study of the Babylonian records. In these we have a snail being drawn along by the tail of a snake or dragon. It is quite possible that we may have there the origin of our constellation Draco, which is the northern constellation, and it is quite possible that this snail may indicate that the stars in it moved with very great slowness. But it is impossible at present to co-ordinate these different fancies together.

A very important paper has recently been published by Mr. Le Page Renouf suggesting that before the year 1500 B.C. the Egyptians really had an idea of meridional observations. These observations are recorded in several manuscripts found in tombs; they seem to have been given as a sort of charm to the people who were buried in order to enable them to get through the difficulties of the way in the nether world.

The hieroglyphs state that a particular star of a particular Egyptian constellation is seen at a particular hour of the night; we have twelve lines representing the twelve hours of the night, and it is stated that we have in these vertical lines the equivalent of the lines in our transit instruments, and that the reference "in the middle," "over the right eye," "over the right shoulder," or "over the left ear," as the case may be, is simply a reference to the position of the star.

If this should be confirmed, one of the remarkable things about the inquiry will be that the Egyptians did not hesitate to make a constellation cover very nearly 90°. In those days evidently they wished to have as few constellations including as many stars as possible, in order perhaps that things might be more easily remembered.

When the zodiac of Denderah was mentioned, I pointed out the constellation of the Hippopotamus very near the north pole. This constellation is referred to in the records in question.

Such then are some of the ideas which are suggested by the recent work of the Egyptologists. You see, I trust, that it is important that this work should be continued as closely associated as possible with astronomical ideas, because, merely taking a very small part of the area of which they have begun the consideration, we have come to the conclusion that, dealing with the temples alone, there seems a very high probability that 3000, and possibly 4000 B.C. the Egyptians had among them men with some knowledge of astronomy, and that 6000 years ago the course of the sun through the year was practically very well known, and methods had been invented by means of which it might in time be better known, and that not very long after that they not only considered questions relating to the sun, but began to take up other questions relating to the positions and the movements of the stars. It is quite probable that 1500 years B.C. at least they had an idea of meridional observations. If this be so, and if more and more can be proved, I think you will agree that, as I said before, astronomy will have a slight opportunity of repaying some of the great debt which she owes to the other sciences.

J. Norman Lockyer.

THE LATER LARVAL DEVELOPMENT OF AMPHIOXUS.

The memoir by Mr. Arthur Willey, B.Sc., of University College, London, on this subject, in the *Quart. Journ. Microsc. Science*, March 1891, deserves more than a passing notice. It is one of the most important contributions which have been made to a knowledge of this very interesting animal. In the summer of 1889, Mr. Willey was sent by Prof. Ray Lankester with the aid of a Government grant to collect the larvæ and embryos of Amphioxus at Faro, near Messina. He returned with a large series, and in the winter 1889–90 worked out in the laboratory of University College, chiefly by means of sections, the history of the formation of the atrial cavity in this animal. In a paper published jointly by Prof. Lankester and Mr. Willey (*Quart. Journ. Micr. Sci.*, August 1890), it was shown that the atrial cavity does not form, as supposed by Kowalewsky and by Rolph, as the result of a down-growth of lateral epipleura; but that it forms as a longitudinal groove which sinks inwards along the ventral surface, becoming floored in by a small horizontal growth on each side corresponding merely to that portion of the adult animal's ventral surface which lies between the two metapleura. The groove, now become a narrow tube, expands right and left, until it acquires the proportions of the adult atrial chamber.

The preserved material brought home by Mr. Willey in 1889 did not enable the observers to determine the mode of origin of the second row of gill-slits. Stages were noted in which there were as many as fourteen gill-slits of the first series (which are placed anteriorly on the animal's right side), and stages were observed, of no greater size, in which two rows of gill-slits were present—one series on the right side and one on the left side of the pharynx; whilst the mouth, which in the specimens with a single series was completely lateral (on the left side), had now taken up a median position.

Mr. Willey again visited Faro in the summer of 1890, for the purpose of determining, by the study of living transparent larvæ, exactly the mode of origin of the second row of slits, and the steps in the "symmetrization" of the larva. The brief account and few unconvincing figures given by Kowalewsky, in 1866, in relation to this matter had not commanded general confidence, although it was felt that so accurate and accomplished an observer could not have been completely mistaken. Balfour had said, in reference to Kowalewsky's observations on this matter, that he was "tempted to suppose that his observations were made on pathological specimens."

Mr. Willey completely and most successfully accomplished the object which he set before himself in his second visit to Faro, and the results obtained are given in the paper under notice, illustrated by three folding-plates. He confirmed the main feature of Kowalewsky's observations, viz. that the first row of gill-slits, after having (so far as the first eight are concerned) taken up a position on the *right* side of the pharynx, rotate downwards across the median ventral line, and rise up into position on the *left* side, whilst, simultaneously, a new series appears on the right side, not one by one, but as many as six being formed at approximately the same moment. Mr. Willey corrects Kowalewsky's brief account in one or two numerical details, and adds some very important facts, which are quite new. He shows: (*a*) that the anteriormost slit of the primary series closes up and disappears during the process of rotation; (*b*) that some of the hinder slits of this series, which are not far advanced when the rotation begins (there being usually fourteen, of which the last six are very small, and lie in the median ventral line), also close up; so that, when the rotation is complete, and the second series of gill-slits has advanced in development to the number of eight, a "critical phase" is reached in which there are only *eight* gill-slits on each side of the pharynx, all fairly well developed. From this time forward new gill-slits are formed on each side behind the last formed, and continue to increase in number so long as growth continues, which appears to be as long as the Amphioxus lives.

But the most important discovery made by Mr. Willey is as to the origin of the endostyle, a structure which has great importance from the fact that it can be clearly identified, on account of its minute histological structure, with the endostyle of the Ascidians.

In the anterior region of the buccal cavity, previous observers have described in very young Amphioxus larvæ (with only one gill-slit) an elongated gland; "the club-shaped gland." It opens to the exterior on the left side, just in front of the big laterally-placed mouth, whence it can be traced, bending down across the median line and passing up at *right angles* to the long axis of the body along the deep surface of the right wall of the buccal cavity. It opens at its apex, as Mr. Willey has shown, into the buccal cavity. Its earliest appearance (as described by Hatschek) resembles that of a gill-slit, though it precedes both the mouth and the first gill-slit in date. Mr. Willey suggests that it is a modified gill-slit. By the side of this club-shaped gland and in front of it, immediately associated with it, is a band-like tract of modified

but the <-shaped epithelial tract does not; it grows rapidly at its angle along the line or interspace between the two series of slits, forming a double tract of modified epithelium consisting of parallel extensions of the two limbs of the <. It is now the epithelium of the hypopharyngeal ridge or endostyle.

Mr. Willey regards the club-shaped gland so intimately associated with the first stages of the endostyle as a modified gill-slit belonging to the secondary (the permanent right-side series). Its early development in *front* of the mouth indicates this; since, when the mouth acquires a median position (passing from the left towards

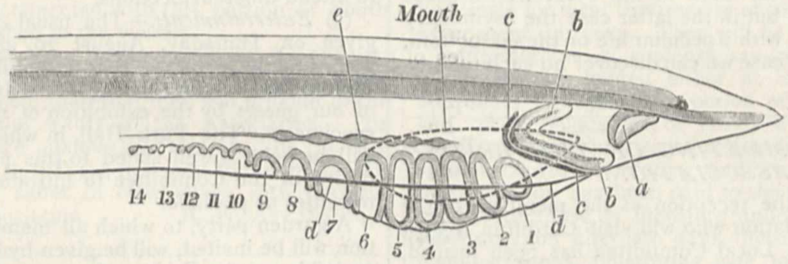


FIG. 1.

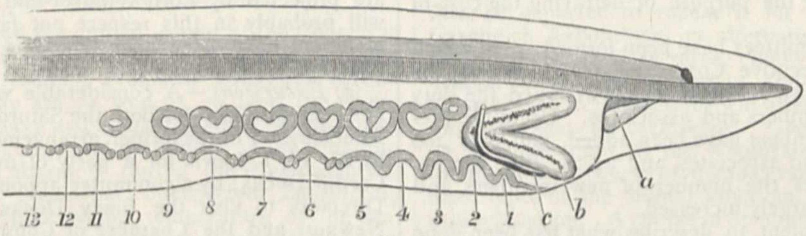


FIG. 2.

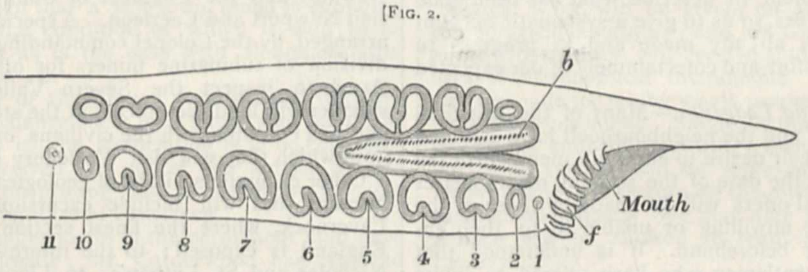


FIG. 3.

FIGS. 1, 2, 3.—Diagrams showing three stages in the development of the gill-slits and endostyle of Amphioxus. Figs. 1 and 2 are seen from the right side; Fig. 3 from the ventral aspect. In Fig. 1 the position and shape of the mouth, which lies on the left side of the animal, are indicated by a dotted oval. The primary series of gill-slits are numbered in all the figures. The secondary series are not numbered. Fig. 2 shows the rotation downwards of the primary series of gill-slits and their nearly complete disappearance from view on the right side; at the same time the secondary series have developed to the number of eight, and the endostyle has become <-shaped, and is pushing its angle between the two rows of gill-slits. Fig. 3 shows the atrophy of the most anterior primary gill-slit, whilst some of the hindermost have disappeared and numbers 10 and 11 are in course of closure and disappearance. *a*, præoral ciliated pit, opening on the animal's left side, but seen through the transparent integument; *b*, the endostyle (<-shaped tract of modified epithelium); *c*, the club-shaped gland; *d*, the edge of the right meta-pleur (the atrial cavity is not yet formed in the anterior pharyngeal region); *e*, the six thickenings which develop the six anterior gill-slits of the secondary (permanent right-side) series; *f*, the præoral tentacles.

intra-buccal epithelium. When there are about eight gill-slits of the primary series present, it is noticeable that the apex of the club-shaped gland is bent over, so that the gland tends to become <-shaped, with the angle directed backwards; the adjoining epithelial tract faithfully follows the bend. At first the upper limb of the < is a good deal smaller than the lower, but as the primary series of gill-slits move from the right side of the pharynx to the left, the two limbs of the < become nearly equal in length, and the angle takes up a position between the primary and the new secondary series of slits. The club-shaped gland-tube now atrophies entirely,

the right by a relative growth, the reverse of that which brings the primary gill slits from the right to the left!), structures just in front of it would be thrown round to the right side, the side of the secondary series of slits. He suggests that it is the early-developed anterior member of the secondary series of gill-slits; and points out that just as this modified gill-slit atrophies, so does its pair in the primary series, viz. the first.

Mr. Willey points out the possible importance of these facts in reference to the views of Dohrn and of Van Beneden, and makes an interesting comparison between the Ascidian tadpole and the Amphioxus larva, with a view to suggesting some explanation of the extraordinary asymmetry of the latter. Mr. Willey thinks that a cause of the one-sided position of the mouth and of the primary series of gill-slits in the Amphioxus larva may be found in the excessive anterior prolongation of the notochord at an early period of development, necessitating a pushing to either one side or the other of the mouth. There appears to be nothing in the mode of life of the larva—a free-swimming ciliated creature—which can be correlated with its asymmetry. The gradual process of "symmetrization," by which the Amphioxus establishes more or less completely a bilateral symmetry on its way to the adult form, is exactly the converse of that process by which the symmetrical larva of the Pleuronectid fishes becomes one-sided; but in the latter case the asymmetry is clearly correlated with a peculiar life on the sea bottom, whilst in the former case we can discover no such relation to environment. E. R. L.

THE CARDIFF MEETING OF THE BRITISH ASSOCIATION.

To arrange for the reception of the members of the British Association who will visit Cardiff in August next, an influential Local Committee has been formed, with the Most Honourable the Marquis of Bute, K.T., Mayor of Cardiff, as Chairman, and a substantial sum has been subscribed for the purpose of defraying the cost of the meeting.

Several sub-committees have been formed, all of which report to the Executive Committee, to which also the Council of the British Association has assigned the duty of electing new members and associates. Up to the present time 7 life members have been added, and over 200 annual members and associates, and as the time for the meeting approaches the number of new members and associates will be largely increased.

It may be convenient to describe what has been done by the sub-committees, so as to give a systematic account of the preparations already made and in progress to provide for the comfort and entertainment of our expected visitors.

(1) *Hospitality and Lodgings.*—Many of the principal residents in Cardiff and the neighbourhood have signified to the Committee their desire to entertain members of the Association, and as the date of the meeting draws nearer numerous additional offers will be made by those of the townsmen who are unwilling or unable to fix their engagements so long beforehand. It is understood that those ladies and gentlemen who have offered to invite guests will send out invitations as soon as it is known to the Committee who are coming.

The hotel and lodging accommodation is not so great as in some other towns, but the Committee feel sure that with the private hospitality which will be offered there will be enough for the needs of our visitors. The list of hotels and lodgings will be ready for distribution about the middle of July, it having been delayed to make the list as complete as possible. The list will be accompanied by a map of Cardiff taken from the most recently executed ones.

(2) *Reception and Section Rooms.*—The reception room will be at the Town Hall, practically the whole of which has been placed at the disposal of the Local Committee for the use of the Association. The vestibule will be devoted to the sale of tickets, the distribution of programmes, and other information, whilst the Assembly Rooms will be fitted up as a drawing-room with writing-tables, post-office facilities, and a book-stall. The Council, Committee of Recommendations, and General Committee will meet in various rooms, and others will be set apart for the officers of the Association.

As the Town Hall is about half a mile from the Section room furthest away, a portion of the Drill Hall, the use of which has been kindly granted by Lord Bute, Colonel Gaskell, and Colonel Page, will be fitted up as a drawing-room, and the remainder will be used as a luncheon-room. As the Drill Hall is situated within very easy distance of almost all the Section rooms, the members of the Association will doubtless appreciate the advantage of having a drawing-room and dining-room so close at hand.

The majority of the Section rooms are very close together, and the greatest distance is not more than half a mile; tramcars and busses, however, run frequently between the extreme points, so that even that distance should offer no difficulty in the way of members wishing to attend different Sections.

(3) *Entertainments.*—The usual *conversazioni* will be given on Thursday, August 20, and on Tuesday, the 25th, and it is hoped that scientific men will aid the Committee in contributing towards the entertainment of our guests by the exhibition of novel experiments or specimens The Park Hall, in which the *conversazioni* will be held, is well suited to this purpose, and it is the desire of the Committee to introduce as many scientific novelties as possible.

A garden party, to which all members of the Association will be invited, will be given by Lord and Lady Bute, probably on the Friday afternoon, though the date may be subject to alteration. Other social entertainments are projected by Lord Windsor and others, and Cardiff will probably in this respect not fall behind what the members have been accustomed to at other places of meeting.

(4) *Excursions.*—A considerable variety of excursions has been provided for both the Saturday and the following Thursday. For the former, arrangements are being made by Sir W. T. Lewis for a party of members to visit the Cardiff Docks; by a committee appointed by the Board of Directors to visit the Barry Docks; by the Mayor of Newport and the Chamber of Commerce for a party to visit Newport and Caerleon. A special excursion is being arranged by the Colonel commanding the Severn Valley division of submarine miners for officers of the British Army to inspect the Severn Valley defences. The steamer will land the officers at the steep and flat holmes, and will continue with the civilians on board to Weston, from which they will visit Worlebury Hill and camp.

Other excursions will be of geological and archæological interest, and will include excursions to Penarth and Lavernock, where the finest section of Rhætic beds in England is exposed; to the interesting dolmens at St. Nicholas and St. Lythan's; to Llantwit-major, where a year or two ago the remains of a Roman villa were unearthed, and where a college is said to have existed in the fourth century; to Tintern Abbey and Raglan Castle, the Forest of Dean, Merthyr, Brecon, and to some of the numerous collieries and iron-works in the South Wales coal-field. A practical natural history excursion is being organized by the Cardiff Naturalists' Society to the Vale of Neath, which from the beauty of the spot should prove attractive. Several owners of works in the neighbourhood of Cardiff have expressed their willingness to throw them open to the members, and arrangements will be made for visits to some of them.

(5) *Publications.*—A guide-book to Cardiff is being prepared for distribution to all members and associates, and the descriptive articles have been intrusted to the gentlemen who were best fitted to write them. The article on the history and archæology of Glamorganshire has been written by the veteran G. T. Clark, of Dowlais, whilst that on the topography of Cardiff was undertaken by the late James A. Corbett, who, unfortunately, died before it was quite complete. Mr. T. Forster Brown, President of Section G, has undertaken the description of the mining, geological, and statistical features of the district; the industrial portion being in the hands of Mr.

Galloway. The geological, zoological, and botanical descriptions have been written by Mr. T. H. Thomas and Prof. W. N. Parker, with the help of many others. The account of the educational arrangements of Cardiff will be treated of by Mr. Whitmell, Inspector of Schools, and Principal J. V. Jones.

The excursions hand-book will contain a map, on a scale of four miles to the inch, of the whole of the district in which the excursions will be held, specially prepared for the Committee by Messrs. Bartholomew and Co., Edinburgh. As detailed accounts as possible of the various points to be seen in the excursions will be given by those having special knowledge: taken together with the guide-book, it is thought that a very complete description of everything connected with this portion of South Wales will be furnished to the visitors.

Other Committees have been formed for the evening lectures and the working men's lecture, but little more can be said about them than that they will provide to the fullest extent for the wants of the Association. The Local Committee are anxious that this shall be the case in every particular, so that the first visit to the metropolis of Wales will not suffer in comparison with previous meetings of the Association. R. W. ATKINSON.

MARINE BIOLOGICAL ASSOCIATION OF THE UNITED KINGDOM.

WE have received the annual report of the Council of this Association, presented at the general meeting on June 24—the President, Prof. Ray Lankester, F.R.S., in the chair. In the sea, as well as on land, the severe winter appears to have had a marked effect on the fauna, and there is also a complaint of mortality in the aquarium attached to the Laboratory during the colder months; a result perhaps somewhat unexpected, considering the comparatively high winter temperature of the sea. We are glad to learn that a self-sown fauna is springing up in the tanks, the condition of which is said to be steadily improving, as is the case with all aquaria after one or two years of use.

Under the head of the library (which ought to be represented in the balance-sheet by a larger sum than is at present debited to it) the Association is to be congratulated on having received the gift of the late Mr. Spence Bate's library, constituting an exceedingly valuable collection of the literature of Crustacea.

Some of the changes made in the permanent staff have been chronicled already: Mr. Calderwood has replaced Mr. Bourne as Director, and has appointed Mr. H. N. Dickson to succeed Mr. Garstang, who took up a Fellowship at the Owens College in December last. Two temporary members have been added to the staff: Mr. F. Hughes, to carry out from the chemical point of view an inquiry into the possibility of manufacturing an artificial bait; Mr. E. W. L. Holt, known already as the author of some papers on Teleostean development, to conduct investigations into the immature fish question as regards the Dogger Bank and the region eastwards of it—the lines of this latter inquiry are sketched in an appendix to the report. Among the fishery investigations of the past year are quoted experiments on the rate of growth and the age of sexual maturity in food-fish, oyster and lobster culture, and the anchovy fishery which the Association desires to initiate. We are glad to see that systematic physical observations are to be taken at the Laboratory in future.

Eleven gentlemen have visited the Laboratory during the year for the purposes of research, some of them on more than one occasion. This number, however, is by no means as large as it should be.

The balance-sheet shows a satisfactory, if small, increase in receipts, the items pointing to an increased use of the Laboratory, both for research and for the purchase of material for teaching purposes. A sum of £500 (in addition to the annual grant of £500) has been placed on the Civil Service estimates for the current year, which will, if passed, place the Association in a position to carry on its work with less difficulty than has hitherto been the case.

UNIVERSITY EXTENSION STUDENTS AT CAMBRIDGE.

THE work done by University Extension students at Cambridge last year was so satisfactory that the Syndicate for local lectures are encouraged to repeat the experiment this year. They will be prepared to receive a larger number of students, say from 60 to 80, most of whom will be lodged either at Selwyn College or at Newnham College. The period of study will last from July 28 to August 22, or nearly a month in all. The Syndicate have just issued a detailed programme of the various courses of study; and we are glad to see that due attention has been paid to the claims of science as well as to those of literature and art. At the chemical laboratory, on alternate days, there will be a course of demonstrations illustrating the methods of chemical manipulation in a short series of typical experiments. The pupils will be first shown each experiment, and will then be expected to repeat it for themselves. At the Cavendish Laboratory, on alternate days, a course of short experimental lectures, chiefly on electricity and magnetism, will be delivered; and most of the experiments shown in the lectures will afterwards be performed by the students for themselves. Geology will be studied, on alternate days, at the Woodwardian Museum, where there will be a course of demonstrations on the leading fossil types of the animal kingdom, from the specimens in the Museum. A course of demonstrations, followed by practical work, will be given, on alternate days, in the physiological laboratory; and Mr. Graham, chief assistant at the Observatory, will receive students and explain the uses of astronomical instruments. Arrangements will also be made for taking small parties of students to the Observatory at night. Single lectures will be delivered by various eminent Cambridge men, and in this part of the work science will be represented by Prof. G. H. Darwin, who will lecture on the history of the moon or some allied subject. We may note that the students in science will be allowed to read in the Philosophical Library.

NORMAN R. POGSON, C.I.E.

WE regret to have to announce the death of Mr. Norman Pogson, for thirty years the Director of the Observatory at Madras. Mr. Pogson has been so long absent from England that, in a sense, he may be said to have outlived his reputation; but those who can recall the condition of astronomy in this country some thirty years since will remember him as a rising astronomer of considerable promise, and as one of the most indefatigable observers at that time. If his subsequent career has not entirely fulfilled his early promise, perhaps the condition of the Madras Observatory is to some extent the cause. We believe that its astronomical equipment is very old and inadequate, and possibly Mr. Pogson has accomplished all that could be done with his instruments and his staff.

Mr. Pogson's astronomical career commenced at Mr. Bishop's Observatory in Regent's Park, at that time under the direction of Mr. J. R. Hind, and he there took part in the observations for forming the ecliptic charts published from that Observatory. In 1851 he left London to assume an assistantship in the Radcliffe Observatory, Oxford, under the late Mr. Johnson; and there his zeal was rewarded by the discovery of several minor planets, in days when the number of the known asteroids was comparatively small, and their discovery conferred some little distinction upon their fortunate discoverer. Of greater importance to astronomy was his subsequent devotion to variable stars and photometry, the latter carried out, we believe, with the apparently inappropriate instrumental means of the heliometer of the Radcliffe Observatory, Oxford. But the result of his investigation of the amount of light that separates two consecutive magnitudes has never been displaced, and the fortunate employment of the number, whose logarithm is 0·4, to express this ratio will probably long connect Mr. Pogson's name with the history of accurate photometry.

After a somewhat short stay at the Hartwell Observatory, Mr. Pogson left England in 1861 to take charge of the Madras Observatory. His direction of that institution will always be remembered in connection with the extraordinary discovery of a telescopic comet, effected in consequence of the telegraphic communication he received from Prof. Klinkerfues, who expected that Biela's comet might be seen in the constellation Centaur, after the brilliant meteoric shower to which that comet had given rise in November 1872. Mr. Pogson looked in the direction indicated, and by a remarkable coincidence found a comet, which he observed on two, and only two, occasions. The orbit remains, therefore, indeterminate, but there is good reason to believe that the object seen was in no way connected with either of the two condensations which together make up the lost comet of Biela. And thus another and not uninteresting chapter was added to the history of this comet. Several volumes of observations have been published under Mr. Pogson's direction; the last bears the date of 1870, so that probably, and as the Director has often lamented, the reductions are considerably in arrear.

It will be interesting to watch the future of this Observatory. It is to be hoped that some steps will be taken to place it more in accordance with the requirements of the present time. We believe that its abandonment has even been canvassed, but it cannot be sufficiently regretted if an Observatory, possessing as that does many historical associations, and occupying a very favourable position on the earth's surface, be allowed to disappear.

W. E. P.

NOTES.

The death of Wilhelm Weber, the illustrious physicist, is announced. He died at Göttingen on June 23. On a future occasion we shall give some account of his services to science.

The second lecture in connection with the Faraday Centenary was delivered by Prof. Dewar, F.R.S., at the Royal Institution on Friday evening last.

On Tuesday, Lord Cranbrook, in the House of Lords, moved the second reading of a Bill the object of which is to allow the managers of science and art schools to transfer them to local authorities when they desire to do so. Lord Cranbrook explained that at present there were considerable difficulties in the way, and that the process was a very long and tedious one. The Bill proposed to make these schools transferable in the same way as ordinary schools could be transferred to School Boards. The Bill was read a second time.

Drs. J. Bornmüller and P. Sintenis propose to occupy the present summer with an investigation of the flora of the islands Samothrace and Thasos, from which very few collections are to be found in European herbaria; also of Mount Athos and of the Bithynian Olympus. They then intend to take up their winter quarters in Mossul, and to spend the following spring and early summer in the comparatively unknown mountainous region of Djebel Hamzin near Bagdad, and the mountains to the north and east of Mossul.

The distinguished Italian botanist, Prof. O. Penzig, is about to start on a botanical expedition to Massowah and Bogos.

Mr. J. T. Nicolson, at present Prof. Ewing's demonstrator in the University of Cambridge, has been appointed to the Chair of Mechanical Engineering in the McGill University, Montreal.

A stall for the sale of "zoological photographs" has just been opened in the Zoological Society's Gardens. It is placed in the centre of the Gardens, near the band-stand, and has an attractive exterior. The photographs sold are mostly representations of animals in the Society's Gardens, but also include some taken in the Jardin d'Acclimatation of Paris, and in other similar establishments.

The marine laboratory of the Johns Hopkins University will be open this summer at Port Antonio on the north-east coast of Jamaica. According to *Science* of June 19, Prof. Brooks and some members of his party had already started for the station.

There has been lately formed in Berlin (we learn from *Naturw. Rdsch.*) a "Union of friends of Astronomy and Cosmical Physics," with the view of organizing practical co-operation in these subjects of research in Germany, Austria, Hungary, Switzerland, and neighbouring countries, and also in the colonies, and where membership may be desired. The object is to be sought by means of free communications of the members or groups of members to head-quarters, whence advice and results of observations, &c., will be issued. Sections are formed for observations (1) of the sun; (2) of the moon; (3) of the intensity and colour of starlight and of the Milky Way; (4) of the zodiacal light and meteors; (5) of polar light, terrestrial magnetism, earth currents, and atmospheric electricity; and (6) of clouds, halos, and thunderstorms. Prof. Lehman-Filhés has been elected President of the Union, and the presidents of the sections are Förster, M. W. Meyer, Plassmann, Jesse, Weinstein, and Reimann.

According to a telegram sent through Reuter's Agency from San Francisco on June 29, a series of sudden sharp earthquake shocks, accompanied by subterranean rumblings, passed through San José, California, that morning. The first shock was so violent that the electric-light tower, two hundred and forty feet high, swayed for at least ten feet. A panic prevailed in the town; and in two of the principal hotels, which were filled with tourists from the East, men and women rushed half-dressed from their rooms into the corridors in a great state of alarm. The city rocked like a ship in the trough of the sea, and when the second shock occurred, buildings rose and fell with a slow undulating motion, one partly erected brick building tumbling to the ground. Many chimneys fell, and a large number of windows were broken, while considerable damage was done to crockery and other fragile articles in the houses.

Germany had very heavy rains on November 22 to 24 last year, causing floods at a rather unusual time in the region of the Elbe, Weser, &c. It is shown by Prof. Hellmann, that Middle and West Germany were then on the front side of a deep depression, which passed very slowly from north to south, taking about 90 hours from the North Sea to Central Germany, less than half the usual speed from west to east. A region of high pressure with cold lay to the east, blocking the course in that direction, and this afterwards spread over the flooded country, covering it with ice.

THE Central Meteorological Observatory at Tokio, Japan, has begun the publication of hourly meteorological observations, commencing with January 1890. The observations are contained in monthly Bulletins, and include all the usual elements, together with vapour tension, humidity, earth temperature, bright sunshine, and hourly and daily means. Meteorological observations have been made for some years in various parts of Japan, including hourly observations at Tokio since January 1, 1886, but have hitherto only been published for certain hours. The observations are all made without self-recording instruments, excepting those of wind and sunshine. Some years ago the Director of the Service, I. Arai, visited this country, and other European countries, for the purpose of studying the various meteorological organizations, and we have no doubt that this important publication will be very valuable for meteorological researches referring to the North Pacific Ocean, where information is comparatively scanty.

M. MASPERO has an interesting article in the current number of *La Nature* on the dog in ancient Egypt. It is illustrated by representations of dogs reproduced from Egyptian monuments, and by a mummy of a dog recently opened and sketched by M. Beckmann. In ancient Egypt, as in modern Europe, the dog was regarded both as a friend and as a useful servant. He also received the honours of a god, and there are cemeteries of dogs (corresponding to the cemeteries of cats) where mummies have been found by the thousand. Attempts have been made to identify the various species of dogs represented in wall paintings, but those naturalists who have investigated the subject have not always arrived at the same conclusions. M. Maspero points out that mummies supply more trustworthy materials for study, and urges that men of science should lose no time in examining some of them, as cemeteries of animals are being very rapidly "exploited."

A COMMERCIAL company has for some time been working quarries in the neighbourhood of the well-known glacial grooves at Kelley Island, Ohio; and it was feared that these remarkable relics of the glacial epoch might be wholly destroyed. Fortunately the president of the company understands the interest of the phenomena, and has taken care to prevent the most striking of them from being injured. We learn from the Cleveland *Leader* that some of the grooves have now been rendered safe, the company at its recent annual meeting having decided that the rocks on which they are furrowed should be made over to the president, by whom they will be transferred to a scientific or historical society, "to be preserved in perpetuity for the benefit of science."

MR. C. DAVIES SHERBORN is, we are glad to find, making satisfactory progress with the stupendous task he has undertaken in the production of his "Index Generum et Specierum Animalium." Mr. Sherborn has found it absolutely necessary to accept the year 1758, the date of the tenth edition of Linnæus's "Systema," instead of the twelfth edition (1766), as the starting-point of binomial nomenclature in zoology, and this decision was greatly strengthened by the advice of Prof. Sven Loven, Dr. D. Sharp, and others who had carefully studied the question. This is the only alteration which has been made in the original scheme (see NATURE, vol. xlii. p. 54). During the year, five hundred volumes have been worked through, page by page, and a total of forty thousand species have been recorded, *in duplicate*, involving a use of 80,000 slips. Each species is recorded on a separate slip (5 inches × 2¼), the whole of the *reference*, with the sole exception of the page, being printed with india-rubber type, thus insuring perfect accuracy of date and parts of volumes: as the pages are also checked during work, the chances of misquotation are reduced to a minimum. As the volumes mentioned include the whole of the publications of Linnæus, many of Fabricius, Thunberg, and other voluminous authors of that early period, it is, perhaps, permissible to think that more rapid progress may be made in future years. The dates of publication of the separate parts of a work have been carefully attended to, and much valuable information has been obtained. Some of this has appeared in the *Annals of Natural History* (Pallas's "Icones Insect.," "Nov. Spec. Quad.," and White's "Journal"), while much remains in manuscript until the final completion of detail admits of its publication. As is well known, the authorities of the Natural History Museum have rendered every facility to Mr. Sherborn for the prosecution of his work, and the storage of the manuscripts within the walls of that institution, reducing the risk of loss by fire to a minimum, is a concession highly valued by the author. One set of the slips is arranged in order of genera, and, on application, is available for reference to anyone compiling a monograph of a genus. The manuscript is frequently consulted by those working at the Natural History Museum, even in its present imperfect state, and will, from the very nature of the method of recording, prove of increasing value as it grows to larger proportions.

IN the report of the trustees of the South African Museum for 1890 it is stated that the curator, Mr. R. Trimen, has completed a thorough rearrangement of the fine collection of South African Diurnal Lepidoptera in accordance with the monograph of those insects recently published by him, incorporating many additional species, and replacing imperfect or worn examples by fresher and more characteristic specimens. He has also begun the rearrangement of the more numerous and less known Crepuscular and Nocturnal Lepidoptera. Mr. Trimen has completed for publication two papers—one on the very interesting series of butterflies collected in South-West Tropical Africa by Mr. A. W. Eriksson, and presented by that explorer to the Museum in 1888; and the other on some additions to the list of extra-tropical South African butterflies since the publication of the concluding volume of his work.

AN interesting account of the nest and eggs of the cat-bird (*Ailurœdus viridis*, Latham) is given by Mr. A. J. North in the latest number of the Records of the Australian Museum (vol. i., No. 6). The habitat of the cat-bird is the dense scrubs of the coastal ranges of New South Wales. Although the bird is common, authentic specimens of its nest and eggs seem to have been unknown until lately. For an opportunity of examining such specimens, Mr. North is indebted to Mr. W. J. Grimes, an enthusiastic oologist, who recently secured two nests of this species on the Tweed River. The nest is a beautiful structure, being bowl-shaped, and composed exteriorly of long twigs, entwined around the large broad leaves of *Ptarietia argyrodendron*, and other broad-leaved trees, some of the leaves measuring eleven inches in length by four inches in breadth. The leaves appear to have been picked when green, so beautifully do they fit the rounded form of the nest, one side of which is almost hidden by them. The interior of the nest is lined entirely with fine twigs. The eggs are two in number for a sitting, oval in form, being but slightly compressed at the smaller end, of a uniform creamy white very faintly tinged with green, the shell being comparatively smooth and slightly glossy. Although the cat-bird is usually included in the family of bower-building birds, Mr. North has never known or heard of its constructing a bower.

A CATALOGUE of the Australian birds in the Australian Museum, at Sydney, by Dr. E. P. Ramsay, is being published. Part III., which has just been issued, deals with Psittaci.

AS a substance peculiarly fitted, by reason of its high dispersive power, and transparency for ultra-violet rays, for study of the ultra-violet part of the spectrum, Herr Wolter has recently recommended, in a Hamburg serial, α-monobromnaphtalin.

With a prism of the liquid, he could trace the spectrum beyond N on a fluorescein-solution. Besides the above-named properties, the substance has for boiling-point 277° C.; it has no offensive smell like carbon sulphide, and its index of refraction varies much less with temperature than in the case of that liquid.

The material resources of the southern part of Maryland are still so imperfectly known that a scientific expedition for the investigation of the district was recently organized. The expedition was formed under the joint auspices of the Johns Hopkins University, the Maryland Agricultural College, and the U.S. Geological Survey. An interesting report of the work done has been published in one of the Johns Hopkins University Circulars.

Dr. Alfred Tuckerman has compiled an excellent "Bibliography of the Chemical Influence of Light," which has been published as one of the Smithsonian miscellaneous collections. As the compiler had in view only the scientific aspects of the subject, he has omitted nearly all the practical applications, including that of photography. An index to the literature of photography is being prepared under the auspices of the committee for indexing chemical literature, of the American Association for the Advancement of Science.

The College of Science, Imperial University, Japan, has issued the first part of the fourth volume of its Journal. It opens with a paper on the fœtal membranes of Chelonia, by K. Mitsukuri. After this come the following articles:—On the development of Araneina, by Kamakichi Kishinouye; observations on fresh-water Polyzoa, by A. Oka; on *Diplozoon nipponicum*, n. sp., by Seitaro Goto; a new species of Hymenomycetous Fungus injurious to the mulberry tree, by Nobujiro Tanaka; notes on the irritability of the stigma, by M. Miyoshi; notes on the development of the suprarenal bodies in the mouse, by Masamaro Inaba. Each of the papers is illustrated.

Mr. C. C. Vevers, Leeds, has sent us a copy of the fourth edition, illustrated, of his "Practical Amateur Photography." The volume is described in the preface as "a simple text-book for the beginner, and a handy work of reference for the advanced photographer." Mr. Vevers has also published an illustrated catalogue of photographic apparatus.

The Manchester Microscopical Society has issued its Transactions and Annual Report, 1890. The volume includes two Presidential addresses by Prof. Milnes Marshall, papers and communications read by the members, and a list of members.

We have received from Mr. William F. Clay, Edinburgh, a catalogue of scientific books which he offers for sale. The works relate to chemistry and allied sciences.

As briefly announced in our report of the last meeting of the Paris Academy of Sciences a new compound of iron and carbon monoxide has been obtained by M. Berthelot, analogous to the nickel compound described last year by Messrs. Mond, Lang, and Quincke. In order to obtain it, the iron requires to be in a very finely divided state, and free from admixed oxide. It is most suitably obtained by reducing dried precipitated ferric oxide or oxide obtained by ignition of ferrous oxalate in a current of pure hydrogen. When carbon monoxide is led over metallic iron thus prepared, and the tube containing it gently warmed to about 45° C., the reaction commences, and if the issuing gas, after being washed through water, is ignited at a jet, the flame is observed to be quite different from that of pure carbon monoxide, being brilliantly luminous, almost white, and emitting rays which furnish a definite spectrum. Moreover, if a cold porcelain tile or evaporating basin is depressed upon the flame a deposit of metallic iron more or less admixed with oxide is obtained, indicating the existence in the issuing gas of the vapour of a ferruginous compound. A drop of dilute hydrochloric acid at once dissolves the stain, and the solution affords the ordinary reactions of iron, yielding Prussian blue with potassium ferrocyanide for instance. When the gases are passed through a strictured tube, such as is employed in Marsh's arsenic apparatus, a portion of which is heated to redness, an annular deposit of metallic iron is obtained, containing a slight amount of admixed carbon. M. Berthelot has not yet succeeded in obtaining sufficient of the new compound to condense it to the liquid form, but further experiments with that end in view are in progress. The formation of this volatile compound of iron and carbon monoxide will undoubtedly prove of great interest from a metallurgical point of view, as it may assist in elucidating several of the as yet little understood furnace reactions. M. Berthelot further expresses the opinion that it may help to explain the formation of bubble flaws in manufactured iron, which have so frequently led to such unfortunate results. In addition to the preparation of iron-carbonyl, M. Berthelot describes several new reactions of nickel carbonyl. It will be remembered that this substance is a liquid boiling at 46°, so volatile that, according to M. Berthelot, its vapour tension at 16° is a quarter of an atmosphere. A drop placed upon a glass plate rapidly volatilizes, the portion last to disappear being for a few moments cooled down by the evaporation of the first portion to such an extent as to form beautiful little crystals. When suddenly heated to 70° it detonates, the detonating reaction being expressed by the equation $Ni(CO)_4 = 2CO_2 + 2C + Ni$. When mixed with oxygen, simple agitation of the tube containing it over mercury brings about detonation. When oxygen is permitted to slowly gain access to the liquid oxide, a solid substance is formed, which is green if the oxygen is moist and brownish-yellow if dry. In contact with oil of vitriol the liquid compound appears to be unaffected for a few moments, but suddenly explodes with production of flame. Nitric oxide reacts in a most beautiful manner, either when passed into the liquid or its vapour, bright blue fumes being produced of a complex compound, which eventually subside, forming a blue solid. These blue vapours completely fill the whole vessel, and their formation affords one of the prettiest experiments yet described.

Contemporaneously with the above work of M. Berthelot, Mr. Mond and his co-workers have also been conducting experiments with the view to the preparation of iron carbonyl, which have been so successful that a brief account of them was laid before the Chemical Society at their last meeting. Further particulars of these experiments will be given as soon as published.

The additions to the Zoological Society's Gardens during the past week include a Rhesus Monkey (*Macacus rhesus* ♀) from India, presented by Mr. Albert Job; an American Red Fox (*Canis fulvus*) from North America, presented by Mr. W. Reading; a Two-spotted Paradoxure (*Nandinia binotata*) from West Africa, presented by Mr. E. G. Parkinson; a Sinaitic Ibex (*Capra sinaitic*) from Palestine, presented by Sir James Anderson; two Gaimard's Rat-Kangaroos (*Hypsiprymnus gaimardi*) from Australia, presented by Mr. Walter Howker; a Cuckoo (*Cuculus canorus*), British, presented by Mr. Stacy Marks, R.A., F.Z.S.; two Red-billed Tree Ducks (*Dendrocygna autumnalis*) from America, presented by Mr. Keswick; two White-faced Tree Ducks (*Dendrocygna viduata*) from Brazil, presented by Captain C. A. Findlay, R.N.R.; a Common Viper (*Vipera berus*), British, presented by Mr. J. Sargeant; two White-headed Sea-Eagles (*Haliaëtus leucocephalus*) from North America, deposited; a Burchell's Zebra (*Equus burchelli* ♂), a Derbian Wallaby (*Halmaturus derbianus*), three Common Night Herons (*Nycticorax griseus*), bred in the Gardens.

OUR ASTRONOMICAL COLUMN.

THE CAPTURE THEORY OF COMETS.—The last three numbers of the *Bulletin Astronomique* (April–June) have contained papers by M. L. Schulhof, "Sur les Grandes Perturbations des Comètes Périodiques," which place beyond doubt the idea that the periodic comets of our system are captured by the perturbing action of planets. The main object of the research was to develop the relations existing between the elements of the comet's orbit before and after its entrance within the sphere of activity of the disturbing planet. With the criteria obtained, and some results previously formulated by M. Tisserand, it is possible to decide the question as to the identity of two comets of which the time of revolution of one is known, even when the comet is believed to have passed several times within Jupiter's sphere of activity between two apparitions. This result is of the highest importance, for it is only by such means that individual comets can be identified. They cannot be recognized by their appearance, as they possess no peculiar characteristic that can be telescopically observed.

M. Schulhof suggests that, in the light of recent work, periodic comets should not now be classified according to their aphelion distances, but arranged in groups the mean aphelion distance of which approximates to the length of the semi-major axis of one or other of the planets. Such a division has been made for comets having periods between 10 and 10,000 years. From the tabulated results, it appears that four comets have aphelion distances which differ but little from the aphelion distance of Mercury. The Venus group numbers seven, the earth's group ten. Mars possesses four comets, and Jupiter twenty-three. Saturn has a family of nine, Uranus eight, and Neptune five.

WOLF'S PERIODIC COMET (*b* 1891).—The following ephemeris is from one given by Prof. Berberich in *Edinburgh Circular* No. 17. From *Astronomische Nachrichten*, No. 3042, it appears that Dr. Spitalier observed this comet on May 2; that is, before Prof. Barnard. The brightness on the date (May 4) of rediscovery by the latter observer has been taken as unity.

Ephemeris for Berlin Midnight.

1891.	R.A. h. m. s.	Decl. ° ′	Log Δ.	Log *r*.	Brightness.
July 6	1 4 34	+ 26 30·3	0·1916	0·2305	3·08
,, 10	1 15 8	27 1·5	0·1800	0·2270	3·30
,, 14	1 25 49	27 28·3	0·1683	0·2237	3·54
,, 18	1 36 35	27 50·5	0·1565	0·2206	3·80
,, 22	1 47 24	28 7·6	0·1446	0·2178	4·06
,, 26	1 58 15	28 19·3	0·1326	0·2152	4·34
,, 30	2 9 7	28 25·2	0·1204	0·2127	4·64
Aug. 3	2 19 57	28 25·1	0·1081	0·2105	4·96
,, 7	2 30 42	28 18·6	0·0957	0·2085	5·31
,, 11	2 41 21	28 5·2	0·0832	0·2068	5·67
,, 15	2 51 51	27 44·7	0·0707	0·2053	6·05
,, 19	3 2 10	27 16·6	0·0581	0·2041	6·44
,, 23	3 12 14	26 40·9	0·0455	0·2032	6·85
,, 27	3 22 0	25 57·3	0·0329	0·2026	7·28
,, 31	3 31 26	25 5·6	0·0204	0·2022	7·72
Sept. 4	3 40 28	24 5·6	0·0080	0·2021	8·18
,, 8	3 49 1	+ 22 57·1	9·9957	0·2024	8·64

The comet is now in Pisces, and in the beginning of September will pass through the Pleiades. M. Bigourdan, of Paris Observatory, observed it on June 12, and remarked that it was "une nébulosité ronde, d'environ 20″ de diamètre, de grandeur 13·3."

YORUBA AND GAZALAND.

AT the meeting of the Royal Geographical Society, on Monday, two papers were read: one by Mr. Alvan Millson, on the Yoruba country, West Africa, and the other by Mr. Denis Doyle, on a journey in Gazaland, in South-East Africa.

The ancient kingdom of Yoruba may be taken as one of the most interesting of the great tribal divisions of West Africa, between the Gold Coast and the Niger.

Landing at Lagos, the only natural harbour on a thousand miles of coast, a narrow entrance with a 15-feet bar leads into the intricate chain of waterways which extends, with few and slight interruptions, for 500 miles from the Volta river to the Benin branch of the Niger Delta. From the east and west, from the Benin river and the waters of the Dahomian frontier, the coast of the gulf is backed by intersecting channels of fresh water flowing steadily from either hand towards the Lagos outlet. In many places these narrow and brimming channels are separated from the onslaught of the Atlantic rollers by no more than five or six level yards of shifting sand; the spray from the ocean drifts over them, and the roar of the surf is heard by the native as he glides over their calm surface in his fragile canoe. These so-called "lagoons of the Bight of Benin" form but a small portion of the littoral river systems of West Africa; for from Cape Palmas to Cape Three Points the long Kroo coast is lined by inland waters for the greater part of 300 miles, and beyond the rocky spurs of the beautiful Gold Coast the Dahomian shores have the same remarkable formation. At right angles to this network of channels numerous rivers flow down from the uplands of the interior, carrying in their rapid streams vast quantities of sand and mud with which they busily build out the land. At first sight it seems strange that so many and such powerful streams, flowing strongly towards the sea should suddenly be turned aside from their courses by so narrow and fragile a barrier of shifting sand. To the influence of the sheltering headlands which jut out towards the south; to the rapid Guinea current which tears away the face of their rocky shores and hurries towards the east a ceaseless stream of sand; to the almost tideless ocean, and the absence of high winds, for the strength and duration of a West African tornado are but slight as compared with the hurricanes of the West Indies or the gales of our stormy coast; and above all to the enormous growths of floating papyrus and water-grass which line the inner banks of the lagoons, and prevent the swollen waters from breaking through into the ocean, are due the formation and continual development of this strange delta system. For these rivers are in most instances choked for many miles by a floating papyrus-sod bound together by wild water-figs and palm-wine palms (*Raphia vinifera*), and when the floods come down from the interior great masses of this floating vegetation are torn away and carried down to the lagoons and onwards towards the sea. Hundreds of acres of these grass islets are annually carried down from each of these rivers, and are driven against the banks of the littoral lagoons, where they lodge and grow, and eventually become anchored in their places by more permanent vegetation. In this manner the lagoon sides are padded for hundreds of yards, and even, in some instances, for two or three miles in depth on either hand, and their banks are protected from the wash of the current and the weight of the accumulated waters. By this means the frail barrier of sea-sand is strengthened, and the inland waters, although they frequently rise to a height of 5 to 6 feet above the sea-level, are effectually prevented from bursting through their banks. Not only are these growths a permanent protection to the land, but by their very nature, floating as they do on the surface of the water, they rise and fall with the floods, and are always ready with their assistance at the right time and place. Were all the rivers which feed the lagoons freed from their natural obstructions, as is the case with the Ogun river near Lagos, the interior to a distance of from thirty to seventy miles would be thrown open to commerce, and the wonderful system of inland navigation which fosters the coast traffic would be still further developed.

Mr. Millson went on to describe a journey from the coast to the interior, the country rising from terrace to terrace. He then spoke at some length of the Yoruba people and country.

About eighty miles from the coast, at Oda Ona Kekere, the dense forest suddenly gives place to open cultivated land, and a densely peopled country. Some three miles to the north of Odo Ona Kekere, from the crest of a rising in the undulating land the great city of Ibadan—the London of Negroland—comes full in view, extending for over six miles from east to west, and for more than three from north to south. Surrounded by its farming villages, 163 in number, Ibadan counts over 200,000 souls, while within the walls of the city itself at least 120,000 people are gathered. Its sea of brown roofs covers an area of nearly 16 square miles, and the ditches and walls of hardened clay which surround it are more than 18 miles in circumference. Its houses are built round courtyards with a single entrance, and form in themselves no mean defence against native inroads. Their walls of thick "adobe" are blank on the outer face, and the thatched roofs are made of a light covering of palm leaves and grass in order to avoid the danger of extensive conflagrations. In the winding rocky streets which intersect these large compounds in every direction, are countless market booths and occasional market places, where the inhabitants can purchase native produce, food, and European luxuries. In the same way, by the sides of the country roads, are built at irregular intervals varying from one to six miles, long low sheds close by some well or running water, where the farm women sit and "make their market." In the farms which extend throughout the country from horizon to horizon as one journeys through it, save where the land is too poor, or the fear of war has desolated the neighbourhood, can be heard the crowing of cocks, the barking of dogs, the shrill laughter of children, and the vociferous clamour of native homestead gossip. For among natives, as among seafaring folk at home, a hundred yards or so is no impediment to polite conversation. From this custom arises the disadvantage that the voices of the people being naturally pitched for distant communication cannot readily be restrained or focussed for nearer ranges of social intercourse. The consequent turmoil and shrill cries are apt at first to unsettle the nerves of an inexperienced traveller, but a few weeks' residence in the country not only accustoms one to their manner of speech, but inures one's system to the sudden shock of their sonorous voices.

Northward from Ibadan, which may be described as the centre of the chief military and commercial power in Yoruba, two days' journey—about 40 miles—through many villages, and a landscape dotted far and near with oil-palms (*Elæis guineensis*) along a road thronged with travellers, brings one to the capital of central Yoruba, Oyo (Awyaw). On leaving Ibadan, Mr. Millson passed, in the course of a morning's march, over 4700 men, women, and children, hurrying into the great city from the farm villages with loads of maize, beans, yams, yam flour, sweet potatoes, fowls, pigs, ducks; or driving cattle, sheep, and goats; or mounted on small native horses which amble quickly along under the combined influence of an Arab ring bit and an armed spur which leaves its traces in deep scores along the flanks of the poor animals. Far and wide the land has for generations, and indeed for centuries, been cultivated by these industrious natives. The hatchet, the fire and the hoe, have removed all traces of the original forest, save indeed where a dark trail of green across the landscape shows where the valley of some narrow watercourse or larger river is hidden among trees. For two or three years at most the land is allowed to lie fallow, while for three or four years double or treble crops are raised with no further cultivation than an occasional scrape with a hoe, and during its fallow time no further care is taken of it than to let a rank growth of reedy grass spring up some 6 or 8 feet in height. Among this grass can be seen the seedlings and young plants of a new forest, which would rapidly take possession were the land to be permanently deserted. In spite of this careless and exhausting method of cultivation the crops maintain an excellent average, and the same plot of ground serves for generations to support its owners.

Mr. Doyle, who accompanies King Gungunhana's two envoys to this country, described his journey from the Mashonaland plateau down through Gazaland to the mouth of the Limpopo. At first the journey was through a broken plateau country, rising to 5000 feet and over, and well adapted for farming operations. After fourteen days' travel, the country suddenly drops from a level of 4000–5000 feet to 860 feet above sea-level. For many miles the altitude was no more than 300 feet, and as it was the rainy season when Mr. Doyle and his companions passed through, they found the country almost entirely a swamp. The actual distance travelled was between 700 and 800 miles, which was traversed in forty-six days.

THE CONDITION OF SPACE.

THE question of the condition of inter-planetary space, with special reference to the possibility that it offers a resistance to the passage of the heavenly bodies, has for long occupied the attention of astronomers, but is even yet far from receiving a satisfactory or definite solution. Three hypotheses seem to be more or less in vogue:—

(1) That it is filled with "ether," differing entirely in its properties from ordinary matter, and offering no resistance to the passage of solid or gaseous bodies. Radiant energy is transmitted by the vibratory motion of the ether, and possibly also the force of gravitation is transmitted by a rotatory motion, though, as Laplace points out, the velocity of the gravitation must be at least 7,000,000 times that of light.

(2) That it is filled with an ether more analogous to ordinary matter, which offers resistance, or with a highly rarefied gaseous medium similar in constitution to our atmosphere.

(3) That it is filled with ether, through which innumerable solid bodies of comparatively small size fly singly or in swarms. When they encounter one another, a gas, or a planet, they become luminous, and present the appearance of fireballs, meteorites; shooting-stars, meteors; comets, meteoric swarms; meteoric dust gives rise to the phenomenon of the aurora borealis. This theory has recently been much extended and admirably advocated by Prof. J. Norman Lockyer, in "The Meteoritic Hypothesis."

If the first hypothesis be true, and space offers no resistance to the passage of the planets, Laplace has shown (*Mém. Acad. des Sciences*, 1784) that any change in their orbits will be periodic, or, in other words, that, with only slight variations from time to time, the present condition of the solar system will continue indefinitely.

If the second hypothesis be true, the resistance, however slight it may be, will tend to retard the motion of the planets. In the case of the earth the friction between the outer layers of the atmosphere and the medium will retard the rotation of the earth, and increase the length of the day. There will also be a resistance to the motion of the earth in her orbit, which will tend to decrease the velocity, and therefore to lengthen the year; but, on the other hand, if the tangential velocity be decreased while the attraction of the sun remains the same, the earth will fall towards the sun, the mean distance will decrease, and therefore the time of revolution will be shortened.

If the third hypothesis be true, the rain of meteorites will have no effect on the rotation of the earth, but will tend to lessen the orbital velocity.

Laplace has discussed some consequences of the second hypothesis in "Mécanique Céleste," vii. 6, on secular variations in the movements of the moon and earth which might be produced by the resistance of an etherial medium spread round the sun. He assumes that the density of the medium is a function of the distance from the sun, and that the resistance varies as the square of the velocity. He concludes that the acceleration produced by the resistance of a fluid ether on the mean motion of the moon is, up to "the present time," insensible; and that the acceleration produced by the same ether on the motion of the earth would be less than 1/100 of that caused to the motion of the moon. These results are extended to other planets and to comets in x. 7, where it is shown that the distance at perihelion remains unchanged, and the only alteration in the orbit is a decrease in the length of the major axis and in the eccentricity.

The question is discussed from a mathematical point of view in several text-books (*e.g.* Tait and Steele, "Dynamics of a Particle," pp. 279, 379), but in all cases the mathematics are somewhat difficult, and various assumptions have to be made to render the solution possible.

In the case of the earth, if the resistance of the medium be small, the orbit may be considered to be circular, more especially as it follows from Laplace's results that the error introduced decreases with the time, since the orbit becomes more nearly circular. The following brief abstract of the popular treatment suggested by G. A. Hirn in his "Constitution de l'Espèce Céleste," pp. 104–108, with the substitution of English values, and the extension of the results to the meteoric hypothesis, may be not without interest at the present time.

Many of the data are so uncertain, that the rough approximations by which mathematical difficulties are avoided probably produce no great loss of arithmetical accuracy in the results.

The *vis viva* of the earth at the end of any period is equal to the *vis viva* at the commencement of the period, less the *vis viva* lost owing to the resistance of the medium, and increased by the *vis viva* due to the fall towards the sun. Transposing, and dividing by M/2—

$$v_r^2 = v_o^2 + v_s^2 - v_t^2.$$

Writing S for the attraction of the sun, and resolving along the radius vector A—

$$v_o^2/A_o = S, \quad \therefore v_o^2 = SA_o.$$

After a time t,

$$v_t^2/A = S\frac{A_o^2}{A_t^2}, \quad \therefore v_t^2 = SA_o^2/A_t.$$

The acceleration towards the sun is expressed by

$$\frac{d^2A}{dt^2} + S \cdot \frac{A_o^2}{A_t^2} = 0 ;$$

and integrating,

$$v_s^2 = 2SA_o\left(\frac{A_o}{A_t} - 1\right).$$

Substituting and reducing,

$$v_r^2 = v_o^2\left(\frac{A_o}{A_t} - 1\right).$$

Hence the *vis viva* lost, owing to the resistance of the medium, is one-half of the *vis viva* gained by falling through $(A_o - A_t)$ towards the sun, and the presence of a very slightly resisting medium *increases* the velocity of the earth in its orbit. This increase is easily expressed, since, by Kepler's third law, we may replace $(A_o/A_t)^3$ by $(T/T_t)^2$, where T_oT_t are the periodic times at the beginning and end of the period;

$$\therefore v_r^2 = v_o^2\left\{\left(\frac{T_o}{T_t}\right)^{\frac{2}{3}} - 1\right\}.$$

But the *vis viva* lost owing to the resistance is equal to the work done in forcing the sphere against the resistance of the medium through the distance passed over by the earth during the time. We may assume for simplicity that during the last 2000 years the length of the year has shortened by five seconds; and since the change in the radius vector would be very small, that $A = 23300a$, where a is the radius of the earth, and hence that the distance through which the earth has passed is $2\pi\ 23300a\ 2000$.

M. Hirn, by theory and experiment, shows considerable reason for believing that the formula of Hutton, for the resistance of a medium in terms of the density δ, gives a result not far from the truth. Hence

$$\cdot 0451 \times (\pi a^2)^{1\cdot 1} \times \delta \times v_o^2 \times 2\pi\ 23300a\ 2000 = \frac{Mv_o^2}{2}\left\{\left(\frac{T_o}{T_t}\right) - 1\right\},$$

where $\left(\frac{T_o}{T_t}\right)^{\frac{2}{3}} - 1 = \left(1 + \frac{5}{31558150}\right)^{\frac{2}{3}} - 1 = \frac{1}{9467445}.$

$$\therefore \frac{1}{\delta} = (\log^{-1}14\cdot 32278) \times ga^{\cdot 2}/\Delta,$$

where Δ is the absolute mass of unit volume of the material of the earth.

$$\therefore \frac{1}{\delta} = 5\cdot 64 \times 10^{14} \text{ cubic feet.}$$

M. Hirn further points out that this decrease of five seconds in the length of the year during a period of 2000 years would be accompanied by a change in the longitude of the earth of more than 205″, an amount quite inadmissible since the time of Hipparchus, while the above results have shown that, to produce an acceleration so small as this, the medium must have a rarity such that one pound occupies 564 billions of cubic feet. And the volume occupied by a pound of the gas very nearly varies inversely as the number of seconds gained in the periodic time.

When we pass on to consider the retardation caused by the action of meteorites, we lose the guidance of M. Hirn, but are able to refer for data to Prof. Lockyer's treatise.

About 30 miles, or 158,400 feet per second, may be taken as the average velocity of meteorites (p. 68). Suppose the earth at rest, and struck by a meteorite weighing one pound with this velocity, the *vis viva* of the blow would be $\frac{1}{2g}(158400)^2 = 3\cdot 98 \times 10^8$ absolute foot-pounds (p. 64).

But the earth is moving in its orbit with a velocity of 18·4 miles, or 97,130 feet per second; hence, of every three meteorites we may presume that two strike the front, and one the back hemisphere. Further, the velocity of the earth is, in the one case, to be added to, and, in the other case, subtracted from, the velocity of the meteorites. Again, we may assume that the earth is struck about equally all over each hemisphere, and that, owing to its attraction, the blows are vertical, and hence that the energy added and subtracted in each hemisphere in the direction of the motion of the earth is one-half of the total *vis viva*, or for three meteorites, each weighing a pound,

$$\frac{1}{2g}\{(158400 + 97130)^2 - \tfrac{1}{2}(158400 - 97130)^2\}$$
$$= 4\cdot 58 \times 10^9 \text{ foot-pounds.}$$

Suppose that a meteorite weighing one pound has the specific heat 0·2, which is about double of that of iron; to raise it from −270° C. to 2000° C., 454 units of heat are required, which are equivalent to about $454 \times 44758 = 2 \times 10^7$ absolute foot-pounds of work—a quantity which may be neglected, in comparison with the total *vis viva* of the meteorite.

The weight of meteorites varies from tons to small specimens (p. 19), and hence we must assume an average weight of μ pounds. According to Newcomb, 20,000,000 meteorites a day enter our atmosphere (p. 69). We may again assume that the action has continued for 2000 years, and caused a shortening in the periodic time of five seconds.

The *vis viva* of the impacts,

$$\mu \times 4\cdot 58 \times 10^9 \times \frac{20000000}{3} \times 365 \times 2000,$$

must be equal to the *vis viva* lost by the earth,

$$\tfrac{1}{2}Mv_o^2\left\{\left(\frac{T_o}{T_t}\right)^{\frac{2}{3}} - 1\right\}, \text{ which is } \frac{4\pi a^3 \times 10\cdot 86 \times (97130)^2}{6 \times 9467445};$$

$$\therefore \mu = \frac{1\cdot 95 \times 10^{33}}{1\cdot 115 \times 10^{19} \times 2000 \times 9467445}$$
$$= 9240 \text{ pounds, or over 4 tons.}$$

In this case, also, the average mass of the meteorites varies inversely as the shortening of the periodic time. Thus, if the average weight of meteorites is 9 pounds, the shortening would be only 0·005 second—an amount probably inappreciable.

SYDNEY LUPTON.

THE FLOWERS OF THE PYRENEES AND THEIR FERTILIZATION BY INSECTS.[1]

THE observations described in this work were made in the Vallée de Luz (Hautes Pyrénées, France), in August 1889 and June 1890, between 900 and 2200 metres altitude. The author has noticed 1801 visits, brought by 507 different insects to 261 different flowers. In the list of the visits, date and altitude are always noted, and in many cases particulars are given about the special habits of insects in visiting flowers. Many of the mentioned insects were not before seen visiting flowers.

The contrivances by which the flowers are fertilized are described for the following species: *Merendera Bulbocodium*, *Asphodelus albus* (lepidopterophilous, proterogynous), *Hyacinthus amethystinus* (proterandrous, adapted to long-tongued bees), *Iris pyrenaica*, *Antirrhinum sempervirens*, *Linaria origanifolia* (adapted to bees, with special entrance for Lepidoptera or Bombylidæ), *Linaria pyrenaica*, *Horminum pyrenaicum* (gynomonœcious), *Scutellaria alpina* (adapted to long-tongued bees, with special entrance for Lepidoptera), *Teucrium pyrenaicum* (adapted to bees, with entrance for Lepidoptera), *Dianthus monspessulanus* (lepidopterophilous), *Alsine* sp., *Alsine verna*, *Aconitum pyrenaicum* (resembles the *A. lycoctonum*), *A. Anthora*, *Aquilegia pyrenaica*, *Brassica montana* (lepidopterophilous), *Roripa pyrenaica*, *Reseda glauca*, *Geranium cinereum* (proterandrous, gynodiœcious), *Saxifraga longifolia* (proterandrous), *Potentilla alchemilloides*, *Potentilla fragariastrum*.

Some details are given about the construction of the flowers in the following species: *Cirsium eriophorum*, *C. monspessulanum*, *Carduus medius*, *C. carlinoides*, *Centaurea Scabiosa*, *Gnaphalium Leontopodium*, *Angelica pyrenæa*. Almost all those species are illustrated (94 figures), and the explanation of each figure is given in French and in Dutch.

General conclusions:—The relative number of hemitrope Diptera (Syrphidæ, Conopidæ, and Bombylidæ), of allotrope Hymenoptera (all Hymenoptera except the bees), of long-tongued not-social bees and of Coleoptera decreases with increasing altitude. The hemitrope Diptera (all Diptera except those mentioned above) become on the contrary relatively more numerous with increasing altitude; this seems to be also the case with the social long-tongued bees (represented in the Pyrenees by *Bombus* and *Psithyrus*). Müller came to the same conclusions about the influence of altitude upon the same groups of insects in the Alps.

[1] "De Pyreneeënbloemen en hare bevruchting door insecten." 226 pages, with five plates, a French *résumé*, and the explanation of the plates in French. In *Botanisch Jaarboek*, iii., 1891, published by the Botanical Society Dodonæa, in Ghent, Belgium).

On the other hand, Müller noticed that in the Alps the relative number of Lepidoptera increases, of hemitrope Hymenoptera (short-tongued bees) decreases in the higher parts of the mountains. The influence of altitude upon those two groups of insects is not evident in the Pyrenees.

The Lepidoptera—which in the Alps, according to Müller, are very numerous—are much less numerous in the Pyrenees. All the allotrope insects (Coleoptera, allotrope Diptera, and allotrope Hymenoptera) are relatively more numerous in the Pyrenees than in the Alps. The hemitrope Hymenoptera (short-tongued bees) are somewhat more numerous in the Pyrenees than in the Alps; the hemitrope Diptera (Syrphidæ, Conopidæ, and Bombylidæ) are almost equally represented in both the mountains. The eutrope Hymenoptera (long-tongued bees) seem to be equally numerous in the Pyrenees and in the Alps: in both countries, the humble-bees are predominant, and the not-social long-tongued bees are scarce.

The following table will enable students to compare the flora of the Pyrenees with that of the Alps:—

	Pyrenees. Species.	Pyrenees. Per cent.		Alps. Species.	Alps. Per cent.
Pollen flowers (class Po) ...	12	(4·6)	...	14	(3·3)
Fl. with free-exposed honey (class A) ...	34	(13·0)	...	42	(10·1)
Fl. with partially concealed honey (AB) ...	45	(17·2)	...	61	(14·6)
Fl. with quite concealed honey (B) ...	37	(14·1)	...	66	(15·3)
Associated flowers with quite concealed honey (B') ...	48	(18·4)	...	84	(20·2)
Flowers adapted to bees (Bb) ...	73	(27·9)	...	110	(26·4)
Flowers adapted to Lepidoptera (Vb) ...	12	(4·6)	...	39	(9·3)

The allotrope flowers (Po, A, AB) are relatively more numerous, the lepidopterophilous flowers (Vb) are less numerous in the Pyrenees than in the Alps; we have seen that the same differences exist for the corresponding groups of insects.

The hemitrope flowers (B, B') are a little more numerous in the Alps than in the Pyrenees; the contrary occurs with the hemitrope insects. There is here accordingly no concordance in the geographical distribution between flowers and insects; but the hemitrope insects are not so constant in the choice of their flowers as the allotrope insects and the Lepidoptera; their influence upon the distribution of the corresponding flowers is therefore not so great as that of the two latter groups. The class Bb and the long-tongued bees are nearly equally represented in both the mountains. The parallelism which occurs between the relative abundance of the classes Po, A, AB, Bb, and Vb, and the relative abundance of corresponding insects, agrees very nicely with the theory of flowers.

It may be observed that in the Pyrenees, with reference to the biological floral organization, the Choripetalæ are, on the whole, on a lower level than the Sympetalæ. Only a small number of Monocotyledoneæ could be observed.

University, Ghent. J. MACLEOD.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

CAMBRIDGE.—The Council of the Senate have appointed Mr. E. Hill, of St. John's College, to be a governor of Woodbridge School, under the new scheme.

The Harkness Scholarship in Geology and Palæontology has been awarded to Herbert Kynaston, of King's College.

Mr. A. A. Kanthack has been elected to the John Lucas Walker Studentship in Pathology, vacated by the election of Mr. J. G. Adami to a Fellowship at Jesus College. Mr. Kanthack is at present in India as a member of the Leprosy Commission.

The managers of the John Lucas Walker Fund have made a grant of £60 to Mr. E. H. Hankin, Fellow of St. John's, for the purchase of bacteriological apparatus required for his researches.

I. H. Burkill, of Caius College, has been appointed Assistant Curator of the Herbarium.

Prof. Ewing advertises for a demonstrator in mechanism, who has had a workshop training in mechanical engineering. The salary is £150 a year.

The annual report of the Local Lectures Syndicate, published in the *University Reporter* of June 23, records a large amount of useful work in so-called University extension. The number of courses given in 1890-91 was 135, with an average attendance of 10,947. The average attendance at the classes held after lecture was 4916, the number of weekly papers sent in 2266, and the number of candidates examined for certificates 1547. The following passages refer to a fresh departure of considerable interest, and of far-reaching possibilities in the future:—

"The grant for technical education which has been put at the disposal of the County Councils has led to an extension of the work of the Syndicate, and it seems not improbable that if a grant of this nature is made permanent a considerable demand will be made upon their staff of lecturers. In Devonshire they have provided at the request of the County Council a Lecturer on Chemistry and a Lecturer on Mechanics, in each case with special reference to applications to agriculture. The lectures in chemistry were given at six centres, those in mechanics at five. The average weekly attendance was—at lectures about 40, at classes about 25, at each centre. In all, 64 students presented themselves for examination, of whom 44 passed, 14 obtaining distinction. The audience comprised a number of boys from elementary and secondary schools, and some working men and farmers and schoolmasters, in addition to the usual mixed audience. The lectures were of necessity arranged rather hurriedly, without sufficient time for the local authorities to complete their organization, and they can only be regarded as an experiment. The Syndicate have reason to think that the experiment has been as successful as under the circumstances could be expected. . . .

"Having regard to the probability of a considerable demand for lecturers in connection with the County Councils, the Syndicate have added to their list several new lecturers whose attainments mark them out as suitable for this work. And in order that the lecturers may have practical acquaintance with the applications of their science to the uses of agriculture, the Syndicate have arranged that they should pay visits to farms of various characters and to the experimental farm at Woburn. These visits are paid under the experienced superintendence of Mr. H. Robinson, of Downing College, the assistant to the Professor of Chemistry. Mr. Robinson conducts also a course of laboratory work with the lecturers, with special reference to agricultural investigations. The Syndicate desire to express their grateful sense of the help which Prof. Liveing and Mr. Robinson have so liberally given. The provision of teaching and guidance in Cambridge for the scientific study of subjects connected with agriculture appears to the Syndicate to be so important for the training of students who may become lecturers on their staff, that they will endeavour to secure a continuance of this assistance, and are prepared to devote a portion of their funds to the purpose."

The *Ordo Senioritatis* for the year shows that 6 D.Sc. degrees have been conferred, 19 M.D. degrees, 72 M.B., and 70 B.C. These figures bespeak the steady growth of the faculties of science and medicine, the numbers in medicine being larger than in any previous year.

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, June 11.—"On Electrical Evaporation." By William Crookes, F.R.S.

It is well known that when a vacuum tube is furnished with internal platinum electrodes, the adjacent glass, especially near the negative pole, speedily becomes blackened, owing to the deposition of metallic platinum. The passage of the induction current greatly stimulates the motion of the residual gaseous molecules; those condensed upon and in the immediate neighbourhood of the negative pole are shot away at an immense speed in almost straight lines, the speed varying with the degree of exhaustion and with the intensity of the induced current. Platinum being used for the negative pole, not only are the gaseous molecules shot away from the electrode, but the passage of the current so affects the normal molecular motions of the metal as to remove some of the molecules from the sphere of attraction of the mass, causing them to fly off with the stream of gaseous molecules proceeding from the negative pole, and to adhere to any object near it. This property was, I believe, first pointed out by Dr. Wright, of Yale College, and some interesting experiments are described by him in the *American Journal of Science and Arts*.[1] The process has been much used for the production of small mirrors for physical apparatus.

This electrical volatilization or evaporation is very similar to ordinary evaporation by the agency of heat. Cohesion in solids varies according to physical and chemical constitution; thus every kind of solid matter requires to be raised to a certain temperature before the molecules lose their fixity of position and are rendered liquid, a result which is reached at widely different temperatures. If we consider a liquid at atmospheric pressure—say, for instance, a basin of water in an open room—at molecular distances the boundary surface between the liquid and the superincumbent gas will not be a plane, but turbulent like a a stormy ocean. The molecules at the surface of the liquid dart to and fro, rebound from their neighbours, and fly off in every direction. Their initial velocity may be either accelerated or retarded, according to the direction of impact. The result of a collision may drive a molecule in such a direction that it remains part and parcel of the liquid; on the other hand, it may be sent upwards without any diminution of speed, and it will then be carried beyond the range of attraction of neighbouring molecules and fly off into and mingle with the superincumbent gas. If a molecule of the liquid has been driven at an angle with a velocity not sufficient to carry it beyond the range of molecular attraction of the liquid, it may still escape, since, in its excursion upwards, a gaseous molecule may strike it in the right direction, and its temporary visit may be converted into permanent residence.

The intrinsic velocity of the molecules is intensified by heat and diminished by cold. If, therefore, we raise the temperature of the water without materially increasing that of the surrounding air, the excursions of the molecules of the liquid are rendered longer and the force of impact greater, and thus the escape of molecules into the upper region of gas is increased, and we say that evaporation is augmented.

If the initial velocities of the liquid molecules can be increased by any other means than by raising the temperature, so that their escape into the gas is rendered more rapid, the result may be called "evaporation" just as well as if heat had been applied.

Hitherto I have spoken of a liquid evaporating into a gas; but the same reasoning applies equally to a solid body. But whilst a solid body like platinum requires an intense heat to enable its upper stratum of molecules to pass beyond the sphere of attraction of the neighbouring molecules, experiment shows that a very moderate amount of negative electrification superadds sufficient energy to enable the upper stratum of metallic molecules to fly beyond the attractive power of the rest of the metal.

If a gaseous medium exists above the liquid or solid, it prevents to some degree the molecules from flying off. Thus both ordinary and electrical evaporation are more rapid in a vacuum than at the ordinary atmospheric pressure.

I have recently made some experiments upon the evaporation of different substances under the electric stress.

Evaporation of Cadmium.—A U-shaped tube was made, having a bulb in each limb. The platinum poles were at the extremities of each limb, and in each bulb was suspended from a small platinum hook a small lump of cadmium, the metal having been cast on to the wire. The wires were each weighed with and without the cadmium. The tube was exhausted, and the lower half of the tube was inclosed in a metal pot containing paraffin wax, the temperature being kept at 230° C. during the continuance of the experiment. A deposit around the negative pole took place almost immediately, and in five minutes the bulb surrounding it was opaque with deposited metal. The positive pole with its surrounding luminosity could be easily seen the whole time. In thirty minutes the experiment was stopped, and after all was cold the tube was opened and the wires weighed again. The results were as follows:—

	Positive pole.	Negative pole.
Original weight of cadmium	9·34 grs.	9·38 grs.
Weight after experiment	9·25 ,,	1·86 ,,
Cadmium volatilized in 30 mins. ...	0·09 ,,	7·52 ,,

Finding that cadmium volatilized so readily under the action of the induction current, a large quantity, about 350 grs., of the pure metal was sealed up in a tube, and the end of the tube containing the metal was heated to a little above the melting-point; the molten metal being made the negative pole, in a few hours the whole quantity had volatilized and condensed in a thick layer on the far end of the tube, near, but not touching, the positive pole.

[1] Third Series, vol. xii. p. 49, January 1877; and vol. xiv. p. 169, September 1877.

Volatilization of Silver.—Silver was the next metal experimented upon. The apparatus was similar to that used for the cadmium experiments. Small lumps of pure silver were cast on the ends of platinum wires, and suspended to the inner ends of platinum terminals passing through the glass bulb. The platinum wires were protected by glass, so that only the silver balls were exposed. The whole apparatus was inclosed in a metal box lined with mica, and the temperature was kept as high as the glass would allow without softening. The apparatus was exhausted to a dark space of 3 mm., and the current was kept on for 1½ hours. The weights of silver, before and after the experiment, were as follows:—

	Positive pole.	Negative pole.
Original weight of silver ...	18·14 grs.	24·63 grs.
Weight after the experiment ...	18·13 ,,	24·44 ,,
Silver volatilized in 1½ hours ...	0·01 ,,	0·19 ,,

In this tube it was not easy to observe the spectrum of the negative pole, owing to the rapid manner in which the deposit obscured the glass. A special tube was therefore devised, of the following character:—A silver rod was attached to the platinum pole at one end of the tube, and the aluminium positive pole was at the side. The end of the tube opposite the silver pole was rounded, and the spectroscope was arranged to observe the light of the volatilizing silver "end on." In this way the deposit of silver offered no obstruction to the light, as none was deposited except on the sides of the tube surrounding the silver. At a vacuum giving a dark space of about 3 mm. from the silver, a greenish-white glow was seen to surround the metal. This glow gave a very brilliant spectrum. The spark from silver poles in air was brought into the same field of view as the vacuum glow, by means of a right-angled prism attached to the spectroscope, and the two spectra were compared. The two strong green lines of silver were visible in each spectrum; the measurements taken of their wave-lengths were 3344 and 3675, numbers which are so close to Thalén's numbers as to leave no doubt that they are the silver lines. At a pressure giving a dark space of 2 mm. the spectrum was very bright, and consisted chiefly of the two green lines and the red and green hydrogen lines. The intercalation of a Leyden jar into the circuit does not materially increase the brilliancy of the lines, but it brings out the well-known air lines. At this pressure not much silver flies off from the pole. At a higher vacuum the luminosity round the silver pole gets less and the green lines vanish. At an exhaustion of about one-millionth of an atmosphere the luminosity is feeble, the silver pole has exactly the appearance of being red-hot, and the volatilization of the metal proceeds rapidly.[1]

If, for the negative electrode, instead of a pure metal such as cadmium or silver, an alloy was used, the different components might be shot off to different distances, and in this way make an electrical separation—a sort of fractional distillation. A negative terminal was formed of clean brass, and submitted to the electrical discharge *in vacuo*; the deposit obtained was of the colour of brass throughout, and on treating the deposit chemically I could detect no separation of its component metals, copper and zinc.

A remarkable alloy of gold and aluminium, of a rich purple colour, has been kindly sent me by Prof. Roberts-Austen. Gold being very volatile in the vacuum tube, and aluminium almost fixed, this alloy was likely to give different results from those yielded by brass, where both constituents fly off with almost equal readiness. The Au-Al alloy had been cast in a clay tube, in the form of a rod 2 cm. long and about 2 mm. in diameter.

[1] Like the action producing volatilization, the "red heat" is confined to the superficial layers of molecules only. The metal instantly assumes, or loses, the appearance of red heat the moment the current is turned on or off, showing that, if the appearance is really due to a rise of temperature, it does not penetrate much below the surface. The extra activity of the metallic molecules necessary to volatilize them is, in these experiments, confined to the surface only, or the whole mass would evaporate at once, as when a metallic wire is deflagrated by the discharge of a powerful Leyden jar. When this extra activity is produced by artificial heat one of the effects is the emission of red light; so it is not unreasonable to imagine that when the extra activity is produced by electricity the emission of red light should also accompany the separation of molecules from the mass. In comparison with electricity, heat is a wasteful agent for promoting volatilization, as the whole mass must be raised to the requisite temperature to produce a surface action merely; whereas the action of electrification does not appear to penetrate much below the surface.

It was sealed in a vacuum tube as the negative pole, an aluminium pole being at the other side. Part of the alloy, where it joined the platinum wire passing through the glass, was closely surrounded with a narrow glass tube. A clean glass plate was supported about 3 mm. from the rod of alloy. After good exhaustion the induction current was passed, the alloy being kept negative. Volatilization was very slight, but at the end of half an hour a faint purple deposit was seen both on the glass plate and on the walls of the tube. On removing the rod from the apparatus it was seen that the portion which had been covered by the small glass tube retained its original purple appearance, while the part that had been exposed to electrical action had changed to the dull white colour of aluminium. Examined under the microscope, the whitened surface of the Austen alloy was seen to be pitted irregularly, with no trace of crystalline appearance.

This experiment shows that, from an alloy of gold and aluminium, the gold is the first to volatilize under electrical influence, the aluminium being left behind. The purple colour of the deposit on glass is probably due to finely-divided metallic gold. The first deposit from a negative pole of pure gold is pink; this changes to purple as the thickness increases. The purple then turns to green, which gets darker and darker until the metallic lustre of polished gold appears.

If we take several liquids of different boiling-points, put them under the same pressure, and apply the same amount of heat to each, the quantity passing from the liquid to the gaseous state will differ widely in each case.

It was interesting to try a parallel experiment with metals, to find their comparative volatility under the same conditions of temperature, pressure, and electrical influence. It was necessary to fix upon one metal as a standard of comparison, and for this purpose I selected gold, its electrical volatility being great, and it being easy to prepare in a pure state.

An apparatus was made that was practically a vacuum tube with four negative poles at one end and one positive pole at the other. By a revolving commutator I was able to make electrical connection with each of the four negative poles in succession for exactly the same length of time (about six seconds); by this means the variations in the strength of the current, the experiment lasting some hours, affected each metal alike.

The exposed surface of the various metals used as negative poles was kept uniform by taking them in the form of wires that had all been drawn through the same standard hole in the drawplate, and cutting them by gauge to a uniform length; the actual size used was 0·8 mm. in diameter and 20 mm. long.

The comparison metal, gold, had to be used in each experiment; the apparatus thus enabled me to compare three different metals each time. The length of time that the current was kept on the revolving commutator in each experiment was eight hours, making two hours of electrification for each of the four negative electrodes; the pressure was such as to give a dark space of 6 mm.

The fusible metals, tin, cadmium, and lead, when put into the apparatus in the form of wires, very quickly melted. To avoid this difficulty a special form of pole was devised. Some small circular porcelain basins were made, 9 mm. diameter; through a small hole in the bottom a short length of iron wire, 0·8 mm. in diameter, was passed, projecting downwards about 5 mm.; the basin was then filled to the brim with the metal to be tested, and was fitted into the apparatus exactly in the same way as the wires; the internal diameter of the basins at the brim was 7 mm., and the negative metal filed flat was thus formed of a circular disk 7 mm. diameter. The standard gold pole being treated in the same way, the numbers obtained for the fusible metals can be compared with gold, and take their place in the table.

The following table of the comparative volatilities was in this way obtained, taking gold as = 100:—

Palladium	108·00	Platinum	44·00
Gold	100·00	Copper	40·24
Silver	82·68	Cadmium	31·99
Lead	75·04	Nickel	10·99
Tin	56·96	Iridium	10·49
Brass	51·58	Iron	5·50

In this experiment equal surfaces of each metal were exposed to the current. By dividing the numbers so obtained by the specific gravity of the metal, the following order is found:—

Palladium	9·00	Copper	2·52
Silver	7·88	Platinum	2·02
Tin	7·76	Nickel	1·29
Lead	6·61	Iron	0·71
Gold	5·18	Iridium	0·47
Cadmium	3·72		

Aluminium and magnesium appear to be practically non-volatile under these circumstances.

The order of metals in the table shows at once that the electrical volatility in the solid state does not correspond with the order of melting-points, of atomic weights, or of any other well-known constant. The experiment with some of the typical metals was repeated, and the numbers obtained did not vary materially from those given above, showing that the order is not likely to be far wrong.

It is seen in the above table that the electrical volatility of silver is high, while that of cadmium is low. In the two earlier experiments, where cadmium and silver were taken, the cadmium negative electrode in 30 minutes lost 7·52 grs., whilst the silver negative electrode in $1\frac{1}{2}$ hours only lost 0·19 gr. This apparent discrepancy is easily explained by the fact (already noted in the case of cadmium) that the maximum evaporation effect, due to electrical disturbance, takes place when the metal is at or near the point of liquefaction. If it were possible to form a negative pole *in vacuo* of molten silver, then the quantity volatilized in a given time would be probably more than that of cadmium.

Gold having proved to be readily volatile under the electric current, an experiment was tried with a view to producing a larger quantity of the volatilized metal. A tube was made having at one end a negative pole composed of a weighed brush of fine wires of pure gold, and an aluminium pole at the other end.

The tube was exhausted and the current from the induction coil put on, making the gold brush negative; the resistance of the tube was found to increase considerably as the walls became coated with metal, so much so that, to enable the current to pass through, air had to be let in after a while, depressing the gauge $\frac{1}{2}$ mm.

The weight of the brush before experiment was 35·4940 grs. The induction current was kept on the tube for $14\frac{1}{2}$ hours; at the end of this time the tube was opened and the brush removed. It now weighed 32·5613, showing a loss of 2·9327 grs. When heated below redness the deposited film of gold was easily removed from the walls of the tube in the form of very brilliant foil.

After having been subjected to electrical volatilization, the appearance of the residual piece of gold under the microscope, using a $\frac{1}{4}$-inch object-glass, was very like that of electrolytically deposited metal, pitted all over with minute hollows.

This experiment on the volatilization of gold having produced good coherent films of that metal, a similar experiment was tried, using a brush of platinum as a negative electrode. On referring to the table it will be seen that the electrical volatility of platinum is much lower than that of gold, but it was thought that by taking longer time a sufficient quantity might be volatilized to enable it to be removed from the tube.

The vacuum tube was exhausted to such a point as to give a dark space of 6 mm., and it was found, as in the case of gold, that as a coating of metal was deposited upon the glass the resistance rapidly increased, but in a much more marked degree, the residual gas in the tube apparently becoming absorbed as the deposition proceeded. It was necessary to let a little air into the tube about every 30 minutes, to reduce the vacuum. This appears to show that the platinum was being deposited in a porous spongy form, with great power of occluding the residual gas.

Heating the tube when it had become this way non-conducting liberated sufficient gas to depress the gauge of the pump 1 mm., and to reduce the vacuum so as to give a dark space of about 3 mm. This gas was not re-absorbed on cooling, but on passing the current for ten minutes the tube again refused to conduct, owing to absorption. The tube was again heated, with another liberation of gas, but much less than before, and this time the whole was re-absorbed on cooling.

The current was kept on this tube for 25 hours; it was then opened, but I could not remove the deposited metal except in small pieces, as it was brittle and porous. Weighing the brush that had formed, the negative pole gave the following results :—

	Grains.
Weight of platinum before experiment	10·1940
,, ,, after experiment	8·1570
Loss by volatilization in 25 hours	2·0370

Another experiment was made similar to that with gold and platinum, but using silver as the negative pole, the pure metal being formed into a brush of fine wires. Less gas was occluded during the progress of this experiment than in the case of platinum. The silver behaved the same as gold, the metal deposited freely, and the vacuum was easily kept at a dark space of 6 mm. by the very occasional admission of a trace of air. In 20 hours nearly 3 grs. of silver were volatilized. The deposit of silver was detached without difficulty from the glass in the form of bright foil.

Chemical Society, June 4.—Mr. W. Crookes, F.R.S., Vice-President, in the chair.—The following papers were read :—The molecular refraction and dispersion of various substances in solution, by Dr. J. H. Gladstone, F.R.S. The paper is a continuation of that laid before the Society in March last, and deals with solid and gaseous substances that have been dissolved in water and other liquids for examination. The results are given in several tables. In the case of organic compounds, the theoretical and experimental numbers are frequently in close agreement. Hydrogen chloride, bromide, and iodide give figures for the molecular refraction and dispersion much higher than the sum of the hydrogen and halogen as determined from the paraffin compounds, and the values rise as the dilution becomes greater. Selenious and selenic acids afford optical values much less than what would be expected from the known values of their constituents. Metaphosphoric acid does the same. The data relating to solutions of salts and alkalies will afford material for a revision of the refraction equivalents of the different metals, and of the electro-negative elements with which they are combined. Ammonia, in contrast with the hydrides of chlorine, bromine, and iodine, appears to be uniform in its optical properties, whatever the strength of the solution. The refraction equivalents of cerium, didymium, and lanthanum were found about 12·4, 16·4, and 15·5 respectively. The molecular refraction for ClO_3 in its salts dissolved in water comes out at about 18·3, that for BrO_3 at 24·9, and for IO_3 at 33·8.—The nature of solutions as elucidated by a study of the densities, heat of dissolution, and freezing-points of solutions of calcium chloride, by S. U. Pickering. The curves representing these properties were examined in the same way as those for sulphuric acid, and similar conclusions are drawn—namely, that changes of curvature, which occur at certain points which are the same whatever property is examined represent the existence of hydrates in solution. The simplest hydrates indicated consist of $CaCl_2$ with 6, 7, and $8H_2O$; more complex hydrates also exist, as in the case of sulphuric acid.—Note on a recent criticism by Mr. Sydney Lupton of the conclusions drawn from a study of various properties of sulphuric acid solutions, by S. U. Pickering. Mr. Lupton (*Phil. Mag.*, xxxi. 418) applies a single parabolic equation to a portion of one of the author's sulphuric acid density curves, where a change of curvature was supposed to exist, and shows that it represents the results accurately if the experimental error is of a certain magnitude. This magnitude is between 1000 and 10,000 per cent. greater than the ascertained magnitude, and the equation represents all errors of like signs as grouped together. Such a representation cannot disprove the existence of the particular change of curvature under examination, still less that of the 101 others examined by the author. The hydrate on which Mr. Lupton considers that his investigation throws "very grave suspicion" happens to be the one which the author has isolated in the crystalline condition. In the discussion which followed, Prof. Ramsay doubted the validity of Mr. Pickering's methods of differentiating his curves. His own experience was that it was impossible to obtain results nearer than 2 or 3 per cent. to the truth. Dr. Armstrong said that he was prepared to believe in the existence of hydrates in solution, but could not imagine that the 102 breaks in the sulphuric acid curves, for example, could be interpreted as evidence of as many distinct hydrates. He was inclined to think that the breaks might be due to change both in the complex water molecules and the sulphuric acid. He was inclined to believe that the hydrate, to which Mr. Lupton's conclusions related, did not begin to form in solution until the temperature sank to within a few degrees of its point of fusion. Dr. Morley said that a break in the curve should indicate that some new hydrate had just begun to form, but need not show what that hydrate was. Thus, a liquid of the composition $CaCl_2 8H_2O$ might be expected to contain, besides the hydrate $CaCl_2 8H_2O$, also higher and lower hydrates, such as $CaCl_2 9H_2O$ and $CaCl_2 7H_2O$. Prof. Rücker said that, in reality, Mr. Pickering's results were obtained, not by calculation, but by a method of observation and experiment applied to curves, which themselves represented the results of other experiments. It was admitted that the curves had to be specially drawn, and the scale of the co-ordinates carefully chosen, if the results were to be satisfactory, and probably the conclusions arrived at depended in a large measure on the details of this preliminary adjustment. In the case of the more striking changes in direction and curvature which were clearly visible in the original curve, the various differential curves did not add much to the information it supplied. He thought that the evidence afforded by these secondary curves of changes of curvature, not otherwise detected, was of the most untrustworthy character. Mr. Pickering said that Mr. Lupton's equation represented the rate of change of the densities as a straight line, while the figure which the actually observed rate of change formed was as different from a straight line as possible. The figures here referred to were the first differential figures (rate of change) deduced directly from the determinations themselves ; the question of the accuracy attainable in differentiating a graph, raised by Prof. Ramsay, did not apply. He thought that Prof. Armstrong was somewhat rash in holding that a particular hydrate did not exist in solution at moderately high temperatures, because he had recognized it at low temperatures only, especially as he (the speaker) had been led to search for it, and finally to isolate it from results obtained at high temperatures. The multiplicity and complexity of the hydrates indicated must endanger the acceptance of his conclusions amongst chemists ; and he was perfectly ready to accept any other explanation of the changes with weak solutions.—Ethylic $\alpha\alpha'$-dimethyl-$\alpha\alpha'$-diacetylpimelate and its decomposition-products, by Dr. F. S. Kipping, and J. E. Mackenzie. This paper contains an account of the preparation and properties of the following compounds : ethylic $\alpha\alpha'$-dimethyl-$\alpha\alpha'$-diacetylpimelate, $\alpha\alpha'$-dimethyl-$\alpha\alpha'$-diacetylpentane, $\alpha\alpha'$-dimethyl-α-acetylcaproic acid, $\alpha\alpha'$-dimethylpimelic acid, and ethylic-$\alpha\alpha'$-dimethylpimelate.—Volatile platinum compounds, by W. Pullinger. The author has studied the volatile compounds of platinum with chlorine and carbon monoxide described by Schützenberger. He describes their behaviour when heated in various gases ; as they do not completely volatilize, a determination of the vapour-density was not possible. He describes a non-volatile compound of the formula $PtCl_6.C_2O_2$, and has also prepared the compound $PtBr_2CO$. Directions are given for the preparation of platinic bromide and iodide, from which it appears that spongy platinum readily dissolves in hot solutions of bromine in hydrobromic acid or of iodine in hydriodic acid.

Mineralogical Society, June 16.—R. H. Scott, F.R.S., President, in the chair.—The following papers were read :—On the occurrence of sapphire in Scotland, by Prof. M. Forster-Heddle.—On the optical properties of gyrolite, by Prof. M. Forster-Heddle.—On Fresnel's wave-surface, by L. Fletcher, F.R.S.

Linnean Society, June 18.—Prof. Stewart, President, in the chair.—Mr. W. H. Beeby exhibited specimens of *Hieracium protractum* and other plants collected in Shetland.—Mr. Stuart Samuel exhibited a dwarf specimen of *Acer palmatum*, and made some remarks on the dwarf trees artificially produced by the Japanese.—Mr. R. V. Sherring showed some cases of dried Bananas, and described a new method of preservation adopted in Jamaica to save waste of small parcels of fruit which would be otherwise unsaleable.—Mr. A. W. Bennett exhibited and made remarks upon a specimen of *Selaginella lepidophylla*, which was found to possess remarkable vitality, and upon proper treatment to resume its normal appearance after having been gathered some months.—Dr. R. A. Prior exhibited samples of the Spiked Star of Bethlehem (*Ornithogalum pyrenaicum*), and stated that, although described in British floras as a rare plant, it is so abundant on the hill pastures around Bath that it is brought to the market there in large quantities under the name of French asparagus, and sold for a penny a bunch.—Mr. R. A. Rolfe showed two hybrid *Odontoglossums* with the parent plants—namely, *O. Wilckeanum* (produced from *O. crispum* and *O. luteopurpureum*) and *O. excellens* (produced from *O. pescatorei* and *O. triumphans*). These had first appeared as natural hybrids out of imported plants, and the parentage was subsequently ascertained under cultivation.—On behalf of Sir George Macpherson Grant, Mr. J. E. Harting exhibited some curiously abnormal horns of the Roe Deer (the result of disease), which had been taken from an animal found dead near Forres, N.B. For the purpose of comparison he exhibited some normal heads of the Roe from other parts of Scotland and Germany, and made some remarks on the causes of variation in the size and form of the antlers to which Roe Deer were peculiarly liable.—A paper was then read by Mr. Spencer Moore on the true nature of *Callus*, and in continuation of former remarks on the same subject (Linn. Soc. Journ., Bot., vol. xxvii., Nos. 187-188). He showed that the outer sieve-plates of the fig are obliterated by a substance giving all the dye reactions of *Callus*, which does not peptonize and will not yield proteid reactions. Many of the inner sieve-plates he found to be stopped up with a proteid *Callus* resembling in every way the substance of *Ballia* stoppers, and the proteid *Callus* of the vegetable marrow. It appeared that true *Callus* would dissolve in a solution of gum-arabic, but whether by agency of a ferment or of an acid he had not yet determined.—A second paper by Mr. Spencer Moore dealt with the alleged existence of protein in the walls of vegetable cells, and the microscopical detection of glucosides therein.

PARIS.

Academy of Sciences, June 22.—M. Duchartre in the chair.—Method for the determination of the equatorial co-ordinates of the centres of the plates which are to form the photographic map of the heavens, by M. Lœwy.—On a generalization of equations relating to the theory of the functions of a complex variable, by M. Émile Picard.—On the determination of the mechanical equivalent of heat, by M. Marcel Deprez. At the meeting of June 8, M. Miculesco described an apparatus he had employed for determining the mechanical equivalent of heat. It is now remarked that the same method was employed by Hirn in the experiments made by him in 1860, and in latter years by M. d'Arsonval.—On the formation of the leaves of *Æsculus* and of *Pavia*, and on the order of appearance of their first vessels, by M. A. Trécul.—On the apparent and real glycolytic fermentation in the blood, and on a rapid and exact method of estimation of glycogen in the blood, by MM. R. Lépine and Barral.—On a telephone receiver of reduced weight and dimensions, by M. E. Mercadier.—Observations of the new asteroid discovered at Nice Observatory on June 11, by M. Charlois. Observations for position were made on June 11 and 12.—Observations of the same asteroid made at Algiers Observatory with the telescope of 0·5 metre aperture, by MM. Rambaud and Sy. Observations for position were made on June 12 and 13.—Extraordinary luminous phenomena observed on the sun, by M. E. L. Trouvelot.—On the determination of spiral surfaces according to their linear element, by M. L. Raffy.—On certain systems of spherical co-ordinates, and on the corresponding triple orthogonal systems, by M. A. Petot.—On the damping of Hertz vibrations, by M. V. Bjerknes.—Transmission of light across disturbed media, by M. A. Hurion.—On the electrolysis of barium chloride, pure or mixed with sodium chloride, by M. C. Limb. With moderate currents the author fails to obtain metallic barium; with the pure salt an infusible body of high resistance is deposited; with the mixed salts chlorine is disengaged at the anode, and, from the results of analyses given, it would appear that among the products of the electrolysis some subchloride must be formed.—The calculation of the temperature of ebullition of any liquid whatever, under all pressures, by M. G. Hinrichs.—Action of heat on solutions of chromium salts: green salts of chromium, by M. A. Recoura.—The constitution of the green chromium salts is elucidated by means of the results of experiments following thermochemical methods.—Researches on osmium, osmiamic acid, and osmiamates, by M. A. Joly. Taking the revised atomic weight of osmium, the analyses of Fritzsche and Struve, as well as those of the author, point to $KNOsO_3$, and not to $K_2N_2Os_2O_5$, as the formula denoting the composition of potassium osmiamate. Relations may be traced between osmiamic acid and the nitroso-compounds of ruthenium, $RuNOCl_3$ and $RuNO(OH)_3$. $O{=}OsNO{-}OH$ may be viewed as the first anhydride of the hypothetical $OsNO(OH)_3$.—On the alkaline zirconates, by M. L. Ouvrard.—On the bromo-iodides of silicium, by M. A. Besson.—On the cyanogen compounds of magnesium, by M. Raoul Varet.—On the action of nitric acid of different degrees of concentration upon iron at various temperatures, by MM. Henry Gautier and Georges Charpy. The writers conclude from their experimental results that "*iron is always attacked by nitric acid, whatever its concentration.*" The action may proceed in two ways—(1) rapid, and accompanied by the disengagement of gas; (2) slow, and without evolution of gas. The latter corresponds to what is known as the passive state of iron.—Action of sodium benzylate upon camphocarbonic ether, by M. J. Minguin.—Comparative influences of the sulphates of iron and calcium on the preservation of nitrogen in naked soils and on nitrification, by M. P. Pichard.—On the value of animal *débris* as nitrogenous dressing, by MM. A. Muntz and A. C. Girard.—On the development of blastodermic leaves in Crustaceæ Isopodæ (*Porcellio scaber*), by M. Louis Roule.—On the disengagement of oxygen by plants at low temperatures, by M. H. Jumelle. It appears that in plants capable of resisting excessive humidity or cold the decomposition of carbon dioxide may continue at very low temperatures, even when respiration has ceased. Conifers such as the juniper-tree, and a lichen (*Evernia prunastri*), in light can assimilate the carbon in the air in an atmosphere having a temperature as low as −30° or −40° C.—The parasitic fungi of Acridians, by MM. J. Kunckel d'Herculais and C. Langlois.—On the supposed post-Secondary granites of Ariège, by M. A. Lacroix.—On the age of a porphyritic granite from the Western Pyrenees, by M. Joseph Roussel.—Experimental researches on muscular exertions, by M. Charles Henry.—Diseases of the bones of chimpanzees, gorillas, and orang-outangs, by M. Etienne Rollet.

CONTENTS.

PAGE