THURSDAY, MARCH 2, 1893.

MODERN OPTICS AND THE MICROSCOPE.

The Microscope: its Construction and Management. Including Technique, Photomicrography, and the past and future of the Microscope. By Dr. Henri van Heurck, &c. English edition re-edited and augmented by the author from the fourth French edition, and translated by Wynne E. Baxter, F.R.M.S., F.G.S. (London: Crosby Lockwood and Son, 1893.)

THIS is a handsome, even a luxurious, book. It is beautifully printed on highly-finished paper, and with a margin ample enough to satisfy the most exacting connoisseur. The illustrations are clearly produced, the binding is admirable, and after a careful comparison with the last French edition, we do not hesitate to say that the translation is as felicitous as it is accurate.

Its author has aimed apparently at an elementary treatise on the microscope, which is nevertheless intended to cover almost the entire field involved in its history, production, and use. The difficulties of such a task are not a few. To be elementary and thoroughly popular up to a limit, very sharply defined, and then to lead on those who choose to follow into the deeper aspects of this many-sided subject, is at once practical and natural. The optics of the modern microscope are the possession of the specialist. Abbe himself has failed to make them accessible to and understanded by any but those educationally equipped. Hence the constant misunderstanding of the fundamental principles of the Diffraction Theory and its related applications so frequently manifest even where the subject is supposed to be more or less familiar.

As might have been readily supposed, the author of this treatise has given evidence of skill in the presentation of the main points of elementary optics; it is, however, clearness and conciseness, not originality, that is to be noticed. The illustrations are those familiar to English text-books for the last quarter of a century, and the diffraction theory has in no way been simplified to the reader of an elementary treatise by that most efficient of all elementary modes of imparting ideas on more or less abstruse subjects, viz. carefully devised and well-explained diagrams.

Considering the object of this treatise, viz. the impartation of knowledge to those not mathematically prepared to follow it in that direction, by giving a concise, clear, and comprehensive view of the meaning and application of the diffraction theory of microscopic vision, the transition from the first to the second chapter will be so abrupt and unlinked as to leave the elementary reader practically in the dark. The chapter on "The Theory of Microscopic Vision" is unexceptional so far as it goes. It cannot be other, it is Prof. Abbe's; but in a treatise claiming to maintain its elementary character more completely than any other similar work which covers so wide a range this is surely not enough.

The diffraction theory of vision is introduced to the tyro with no explanation of what diffraction is, and with no illustration of its action until he is plunged *in medias res* in Abbe's application of it to the profoundly important and inestimably valuable theory itself. The "elementary" character of this is at least questionable. Beyond this that most important factor in the diffraction theory in its practical application, Numerical Aperture, is wholly without explanation, save such as arises from its technical introduction and employment; but there are few points on which it is more important that an elementary student should be more clearly instructed, and there are few that lend themselves more to efficient diagrammatic presentation. In the same relation it may be noted that the very essential formula n sin u—expressing the general relation discovered by Abbe between the pencil of light admitted into the front of the objective, and that emerging from the back lens of the same, which is such that the ratio of the semi-diameter of the emergent pencil to the focal length of the objective could be expressed by the sine of half the angle of aperture (u) multiplied by the refractive index of the medium (n) in front of the objective or n sin. u—but this is a German mathematical formula; and its English equivalent is μ sin. ϕ, and although the German form of symbol is employed in England, and thoroughly understood by mathematicians, those who are entering for the first time upon a study of this difficult subject, and therefore unaccustomed to the mathematical formulæ employed, might readily fall into confusion, seeing that the "elementary" source of their information leaves them without a hint on the subject.

Another serious defect, as we believe, in this "elementary" presentation of the diffraction theory of microscopic vision is the absence of an easy explanation of the *photometrical* equivalent of different apertures. Certainly it is not of the essence of the problem, but it is just one of those points which in a very marked and instructive manner illustrate the meaning and value of numerical aperture as such; and for elementary exposition this must be of importance. Thus, if two circles be taken to represent the backs of two objectives of the same power but of different apertures, and the radius of one be twice that of the other, then each radius will represent the angle n sin. u. But because the areas of these circles are to each other in the proportion of the squares of their radii, it follows that if each radius be designated by n sin. u, the area of the lesser circle will be to the area of the greater circle as the square of the radius of the former is to the square of the radius of the latter. Hence the area of the greater circle will be four times as great as that of the lesser, which teaches that since the numerical aperture of one objective is twice as great as that of another its illuminating power will be *four times* as great—a most important incidental and explanatory *raison d'être* for great N. A.

In this connection we notice what is certainly not easily explicable as an exposition of the details of Abbe's great theory. On page 56 of "The Microscope" Dr. Van Heurck almost incidentally states the very important fact that "Prof. Abbe has satisfactorily established the fact that a certain relation must exist between magnification and angular (?) aperture." This is undoubtedly one of the most important demonstrations of the theory. Great numerical apertures have proved of untold value to the competent student of minute details, by opening up structures that mere amplification must have left for ever impenetrable. But that does not annul the importance of small apertures. Low amplifications are as useful in their own department as high ones; and to put great apertures to lower magnifying powers than such magnifying power warrants is to sin against the elementary principles of the Abbe theory of vision. And on the other hand, wide apertures can never be utilised unless there is a concurrent and suitable linear amplification of the image which is competent to exhibit to the eye the smallest dimensions which are by optical law within the reach of such apertures.

Thus it follows that great amplification will be useless with small apertures. If the power be deficient the aperture will not avail; if the aperture be wanting nothing is gained by high power. The law is, "Employ the full aperture suitable to the power used." In Abbe's words, "A proper economy of aperture is of equal importance with economy of power." [1]

Taking these facts, then, which are apparently recognised by Dr. Van Heurck, it is very remarkable to find on page 49, in a discussion of the "screw threads" or gauges employed by the makers of microscopes, that the general value of the English gauge is admitted, but it is added, "The English thread is not, however, all that we have to say on this matter. In America the *American thread* is also employed, which is considerably greater, and admits the use of lenses with a much larger diameter, *and thus offers certain advantages.* In the first place, the larger the lens the easier it is to make, and consequently the real curvatures approach closer to the calculated curvatures; then the larger the lens the more luminous rays it admits, and this in photography is not to be despised."

To our judgment this statement is a contradiction of the admission made on page 49, quoted above.

The enlargement of the screw for the purpose of putting in larger back lenses to objective combinations was first mooted in America in 1879,[2] when "Mr. Bullock urged the desirability of adopting a uniform objective screw of larger size than the Society screw now in use (1879), as being essential to the efficacy of *low power lenses of high angle.*"

This "American gauge" was subsequently introduced and known as the "Butterfield gauge of screw for objectives."[3]

Now, we must remember the date of the introduction of this large gauge for objectives, and its relation to the introduction of the apochromatic system of lenses. We must further remember that the purpose of its adoption was to permit the introduction of larger back lenses than the Society gauge would suffer into an objective combination. This meant giving relatively great apertures to lower powers. But this, carried beyond a certain limit, violated a fundamental law of Abbe's theory.[4] Now it is said that these larger lenses are easier to make (!) and approach more nearly to the calculated curves. But in truth objectives with wide apertures which are low powers, and must therefore have large backs, are most difficult lenses to produce. It was, in fact, to escape the difficulty of giving lower powers larger angles that opticians of the first rank always designated their objectives as of lower magnifying power than they really were. They in fact made a $\frac{2}{3}$rds a $\frac{1}{2}$; a $\frac{1}{2}$ a $\frac{4}{10}$ths; a $\frac{4}{10}$ths a $\frac{1}{4}$; a $\frac{1}{4}$ a $\frac{1}{5}$; and so on.

Since Butterfield's gauge was introduced, long before the days of apochromatism, that is when our ignorance allowed us to over-aperture our low magnifying powers, it was tolerable, because it was evidence of experimental effort to improve the capacity of our lenses. But to-day *with* the society screw we are easily provided with a series beginning with a 1 inch objective of ·3, and a $\frac{1}{2}$ inch objective of ·65 N.A., and we may venture to think that these are the highest ratios of aperture to power that will be accomplished for many a day; and therefore the highest ratios allowable by the Abbe theory of vision, which we now know, at least in this point, to be an enunciation of the established laws of optics.

Moreover, *these* lenses are really difficult to make, with their back lenses easily placed within the diameter of the Society screw. A high ratio of aperture to power always involves great expense in production; and therefore we find that the *low-priced* oil immersions of this immediate time are $\frac{1}{12}$ths and $\frac{1}{8}$ths, not objectives of low magnifying power, and for this reason only.

Since then the Society screw is sufficient for more than double the apertures shown by Abbe to be in suitable ratio to the lower powers, we find it more than difficult to account for the teaching in a treatise intended to be essentially elementary, that the Butterfield screw gauge for objectives provides conditions which "offer certain advantages," when the supreme object of this part of the book is to enunciate fully the nature and qualities of oil immersion achromatic, and especially apochromatic, object glasses, by which we can get larger apertures with the society screw than in the old days of Butterfield's gauge could be got by the use of abnormal backs to objectives. We find also that "penetrating power" is referred to in passing as one of the properties of object glasses (p. 56); but since the diffraction theory of microscopic vision is associated with a special interpretation of what this means, and since it is to Prof. Abbe that we are indebted for placing this hitherto obscure matter on a sound, scientific basis, it somewhat disappoints the reader to find no allusion whatever to the valuable work done on this subject, nor any elementary endeavour to explain the great truth that the actual depth of vision must always be the exact sum of the accommodation depth of the eye and the focal depth of the objective. But there are few matters of more practical importance or that lend themselves more to simple exposition.

In a treatise purporting to be essentially for the beginner we confess to disappointment concerning the instructions as to the "choice of a microscope." What is needed is that the tyro should know the *essentials* of the instrument; the points in it that are of indispensable importance, and a clear account of the manner in which these may—by the uninitiated—be seen to be of inferior or acceptable workmanship. The reader is not even informed that in so important a matter as the *fine adjustment* there is a different value to be attached to several entirely different methods by which this function of the microscope is performed. The bar and lever movement, essentially the best in principle and practice, is only referred to as existing, in the index, which is thus

[1] J. R. M. S., ser. ii. vol. ii. p. 304.
[2] *American Naturalist*, vol. xiii. p. 60.
[3] J. R. M. S., ser. ii. vol i. p. 301.
[4] *Ibid.*, vol. ii. p. 204.

made to serve as a kind of glossary; and even more remarkable is the fact that the patent lever fine adjustment of Swift and Son, the only fine adjustment which, in our judgment, makes the "Jackson Model" microscope (which Dr. Van Heurck evidently affects) at all a practicable instrument, is treated in the same way. So indeed is Campbell's differential screw; and the highest commendation is given to the form adopted in the author's own model. No doubt in its present form it is relieved of many defects incident to the form of fine adjustment to which it belongs; but it must be remembered that we are told that each of the divisions of the milled head of this fine adjustment corresponds to the $\frac{1}{1500}$th of a millimetre. Yet the screw which gives this fine result has to lift the whole "body" of the instrument. In the lever fine adjustments only a nose-piece is lifted, having an inconsiderable weight, and producing in practice no friction, and to this the objective is attached; it certainly appears but reasonable, as it has proved in practice to workers who have employed the several methods for continuous years, that the "wear and tear" upon so fine a screw to which such heavy work is given does not contribute to permanent steadiness, or in constant work, to continued accuracy.

In fact, after careful study of the microscope specialised in this treatise, it is difficult to discover anything really new or distinctive in it save the bringing of the fine adjustment pinion of the sub-stage above the level of the principal stage. The value of this may be variously assessed, but it has the plain disadvantage of preventing the complete rotation of the principal stage; and it may be doubted if it has any advantage which will compensate for this.

There is little, if anything, to enable the reader to distinguish as to the practical value of one form of stand as compared with another, and yet there can be no greater divergence in form than that between the Continental stand on the one hand with its dead weight to produce steadiness, and the two English models known as the Ross and Jackson models respectively on the other. What distinguishes them, in what either of them has superiority over the other, and wherein in any of them what is essential to a first-rate working microscope, is nowhere discussed.

It is true that the models of many makers are presented and beautifully printed; but many of these are not printed in these pages as revealing essential differences important for the reader to observe, but they are placed amongst others simply as the productions, with slight variations, of the same instruments by different makers. We cannot but believe that if some plain directions had been given as to the essentials of a good microscope, and the principal models passed in review showing their conformity or otherwise to these requirements, the "elementary" object of the book would have been more fully accomplished, and the tyro more fully aided in the "choice of a microscope."

Dr. Van Heurck has shown his practical knowledge of the microscope as a manipulator in many ways, in this book, but perhaps this is nowhere more fully seen than in his full appreciation of the *condenser* as an indispensable instrument in bringing out the finest optical possibilities of the most perfectly constructed object glasses. His book may be said to be alone amongst continental treatises on the microscope in this respect. It has been by very tardy steps that the continental makers, or the continental microscopists, have learned to appreciate the immense importance of a condenser in causing optical combinations to give their highest results. It is but recently that so leading a firm as Zeiss has yielded on this point and produced condensers. The first was chromatic, and, as a consequence, proportionately unsatisfactory. Then came the most useful achromatic form of Abbe. But we are glad to observe that Van Heurck recognises that the *apochromatic* immersion condenser of Powell "is the most perfect condenser which exists at present" (p. 85). It is inevitable that with apochromatic objectives it should be. We cannot possibly see how the splendid objectives on apochromatic principles can give their finest results unless they are illuminated by an apparatus which is not only as perfect in workmanship, but of as great a numerical aperture, and with as complete corrections as the objective which is collecting the light and forming the image of the object the condenser is illuminating.

And for this reason, while we admit fully that the plate of photo-micrographs produced in this and other volumes by the very exceptional skill of Dr. Van Heurck with the most remarkable object glass which the manipulative skill of man has yet produced, viz. the 2·5 mm. with N.A. 1·63, is a monument to his manipulative ability, we still contend that he worked under difficulties of no small importance. The only condenser provided for this lens by the great firm which produce it, is one which of necessity has a flint front, but is as wholly uncorrected as the glasses used by Hooke or Bonanni!

Now if it be important to use an apochromatic condenser at all, how much more important to use it on such a lens, with such an aperture and such exquisitely refined corrections. This objective has never yet had its best power revealed, because its illumination has been always a counteraction of its own refinements.

We are surprised that in manipulation the tyro is recommended in this treatise to focus *down* upon the object first, of course with great care, and then to find the actual focal point by withdrawing the tube by either coarse or fine adjustment. A far more elegant and safe method is certainly adopted, and we doubt the preference expressed for daylight as the best constant source of illumination. It is uncertain and always variable and more refractory than the edge of a good lamp-flame, unless we need a monochromatic ray from a sunbeam.

At the close of the book there is a communication which had appeared before in the Journ. Roy. Micro. Soc., from Dr. S. Czapski, which gives a suggestion for the possible enlargement of the practical N.A. of homogeneous object-glasses, which makes an advance to 2·0 possible without the employment of the dense flint and highly refractive media needed by the lens spoken of above. In fact it is plain that true monochromatic light may increase a N.A. of 1·40 to 1·75.

There is a chapter on photomicrography which has the value that is inevitable, coming as it does from one of the most practised and efficient workers; still it can hardly be expected to be exhaustive, and every practical photomicrographer has, and adopts as most perfect, his own methods; and as none will ever become photomicrographers who have not some ingenuity and enthusiasm, it is only needful that they be set to work, and they will undoubtedly find *their own* "best methods."

This treatise is too general to expect from it more than useful and suggestive hints on the subject of the preparation and mounting of objects; and the same may be said as to the history of the microscope, which is nevertheless given in an interesting and useful manner. The book will undoubtedly attract many readers, and it will afford help to many who are seeking it; but we respectfully doubt whether it will enable the elementary reader to fully follow the diffraction theory of microscopic vision, so as to be able to understand its application to the wide range of subjects supposed to be dealt with from that point of view by this sumptuous treatise.

W. H. DALLINGER.

A UNIVERSITY EXTENSION MANUAL.

The Earth's History: an Introduction to Modern Geology. By R. D. Roberts, M.A. (Camb.), D.Sc. (Lond.). With Coloured Maps and Illustrations. (London: John Murray, 1893.)

THIS is not a large book, and a slightly less ambitious title might have been more appropriate. Certainly it is an introduction to the study of modern geology rather than a history of the earth, for the latter is regarded from a limited point of view. But from the page preceding the frontispiece it appears that the volume is one of a series of "University Extension Manuals." It partakes, therefore, of the advantages and disadvantages of this method of disseminating knowledge.

The topics treated by Dr. Roberts are the progress of geological thought: the beginnings of the earth's history: the modifications of its surface due to forces destructive and reproductive: the movements of its crust, including the action of volcanoes. Finally he deals with the formation of rock masses, and attempts to give—though of necessity this subject is very imperfectly treated—some idea of the evolution of the British Islands.

The materials employed by the author are not generally novel, for one text-book must draw from much the same storehouse as another, but Dr. Roberts has a lucid and pleasant method of statement, gained no doubt by his experience in the lecture room. One point, however, though it relates to a well-worn subject, will be fresh to most readers. In speaking of the submergence of the so-called Temple of Serapis at Puzzuoli, Dr. Roberts cites a passage from the Acts of Peter and Paul, an apocryphal booklet, to which attention was drawn a few months since by Mr. Thomson (*Geol. Mag.*, 1892, p. 282). This states that Pontioli (Puteoli, now Puzzuoli) was submerged as a punishment for the martyrdom of Dioscurus. "They all see that city Pontioli sunk into the sea-shore about one fathom, and there it is unto this day for a remembrance under the sea." On which passage Dr. Roberts observes that when the Acts was written, "Puzzuoli was under water, and had been so for so long a time that the memory of the actual events had been lost and replaced by the tradition recorded in the Acts." At first sight this, as he says, seems in favour of the submergence having occurred "between the third and fifth centuries, and probably earlier than the fourth."

This passage certainly makes it probable that the submergence began at a rather early time, but it is no easy matter to fix the date of any passage in these Acts. Parts of the book are believed to be as old as the second century, while others are not earlier than the fifth century. The book, also, was not of Western but of Eastern origin. Had the book been written in Italy then, notwithstanding its other absurdities, some weight might be attached to a topographical reference; but these, as it was compiled at a distance, and by obviously ignorant people, seriously impair its credit. It is also needful to show that this story forms part of the later recensions and is not merely founded on some vague tradition of change of level in the neighbourhood. In any case, Dr. Roberts seems to go a little too far in saying "this would allow about ten centuries, during which the marble columns were under water exposed to the action of the living molluscs." Hardly so; this tradition at most would not take us beyond the first submergence, that indicated by the brackish water deposit at the base of the pillars. Over this came an irregular mass of volcanic ash, which was covered by a calcareous tufa, in places full four feet thick. The former, of course, may have accumulated in a few hours, but the latter must indicate a considerable time. The temple, also, must have been in complete ruin before the showers of ashes fell—which also would require time. So that Dr. Roberts perhaps would have done better to have adhered to the more cautious statement in Mr. Thomson's letter, and not claimed quite so long a period for the maximum submergence.

Within the limits, which the necessities of the case impose, the book is well conceived and well executed: though we cannot help doubting the wisdom of encouraging, by manuals necessarily partial and incomplete, students to imagine that they have really mastered a subject; at any rate, it should be frankly admitted that this, however useful and interesting, is not education.

OUR BOOK SHELF.

The Health Officer's Pocket-Book. By E. F. Willoughby, M.D., D.P.H. (London: Crosby Lockwood and Son, 1893.)

THIS is a work the object of which is to provide a portable and well-bound book of reference, to which the health officer may turn at any moment for most of the facts, formulæ, and data required in his daily practice; and while one cannot give unqualified assent to Dr. Willoughby's contention that such a book is indispensable, one is prepared to acknowledge that it may prove to be useful. It is not easy, however, to conceive the conditions under which a health officer is called upon to take action or to give advice, at a moment's notice, upon points so remote from the routine practice of his duties that he will ever find it necessary to carry about, for consultation, a pocket-book of abstruse sanitary facts and formulæ and legal enactments. If such a work is indispensable, the author would have done well to restrict its bulkiness somewhat, and more especially since he could have achieved this by the omission of a great deal of matter which is, on the face of it, foreign to the purpose of the book. To instance such:—The parts which nitrogenous and non-nitrogenous food stuffs play in the animal economy; the origin and nature of cyclones; a quantity of discursive material upon vital statistics; and a host of elementary hygienic facts with which every sanitarian is conversant,—are none of them points it can ever be necessary for the health officer to carry about with him for hasty reference.

The most useful sections, and those which most justify the *motif* of the book, are the following:—Those which deal with mathematical problems, and set forth useful algebraical and trigonometrical formulæ, together with a few logarithm tables; that upon demography and vital statistics; and the serviceable abstract of sanitary law, in which corresponding or similar sections of the Public Health Act, 1875, and the Public Health (London) Act, 1891, are considered side by side.

There is very little in the book which is not correct and up to date, save that which refers to the subject of water analysis. This contains many errors, and, since the utility of its introduction is very questionable, it is regretable that it mars the all-round accuracy of the work. In this section Dr. Willoughby gives several results of his own analyses, and those who are familiar with the subject will find their experiences much at variance with the writer's.

In what he calls a typical sample of *rain-water* he found 0·63 grains per gallon of nitrates as HNO_3, and 0·114 and 0·172 parts per million of "ammonia" and "albuminoid ammonia" respectively; in *river-water* at Latchford he found no nitrates, not even a fraction of a part per million, and the "ammonia" and "albuminoid-ammonia" were 0·08 and 0·16 (parts per million) respectively. Loch Katrine water is, moreover, credited (and Wanklyn is quoted as the authority) with 0·008 parts per million of "albuminoid-ammonia," and with 0·004 of "ammonia;" and the former is said to correspond to 0·0056 grains per gallon!

While unquestionably the work contains some material which will make it useful to the health-officer, the health student will find much in it which he may peruse with advantage.

Engler's Botanische Jahrbücher für Systematik, Pflanzengeschichte und Pflanzengeographie. (Leipzig: W. Engelmann.)

SINCE Dr. A. Engler's appointment to the post of Director of the Berlin Botanical Garden and Museum, this periodical has become the organ of the very active staff of botanists of that establishment; and the comparatively recent German colonial policy has revived the interest in systematic and economic botany, to which it is devoted chiefly. Vols. xv. and xvi. are being published concurrently. This publication is partly devoted to original work and partly to a review of contemporary botanical literature. The fifteenth volume is largely taken up by contributions to the flora of tropical Africa, in the form of an elaboration by various botanists of the extensive collections made by numerous German travellers. Quite a host of new species are described, but, truth to say, nothing very remarkable in new generic types. *Hybophrynium* is a new genus of Scitamineæ, near *Trachyphrynium*, with which it was generically associated by Bentham and Hooker; and the Aroideæ, elaborated by Engler himself, include two or three new genera. *Pseudohydrosme* is characterised by a large, almost truncate spathe and a spadix without any terminal naked continuation.

Dr. J. Urban, who has been for some years engaged in collecting materials for a general flora of the West Indies, contributes "Additamenta ad Cognitionem Floræ Indiæ Occidentalis," a critical work, both from a botanical and a literary standpoint. No new genera are described.

One of the most interesting articles in the sixteenth volume is by Dr. O. Warburg, on the mountain plants of Kaiser Wilhelm's-Land, New Guinea. The collection of plants dealt with consisted of only fifty-three species, whereof thirty-two were supposed to be endemic, though the material of a few was insufficient for description. Two new genera are described, namely, *Hellwigia pulchra*, a pretty scitamineous plant, and *Zoelleria*, a singular boragineous plant, described as having ten nutlets in the place of the usual four! Among the new species are five rhododendrons, and the most noteworthy feature of the collection was the absence of essentially Australian types.

Another paper of general interest is Dr. Kränzlin's "Beiträge zu einer Monographie der Gattung Habenaria," excluding *Platanthera*, united with *Habenaria* by some botanists, 347 species are described; and they are spread over nearly the whole area inhabited by orchids.

Dr. Carl Bolle's "Botanische Rückblicke auf die Inseln Lanzarote und Fuertaventura" is a pleasantly written essay on the indigenous and cultivated plants of these islands. The "Jahrbücher" contain many other valuable articles. W. B. H.

Descriptive Geometry Models for the use of Students in Schools and Colleges. Designed by T. Jones, M.I.M.E. (Moss Side, Manchester.)

THE models are six in number. They are intended to show a line (1) by its projections, (2) by its traces; the inclination of an oblique plane (3) to the vertical plane, (4) to the horizontal plane; and to determine the angle (5) between two intersecting lines (6) between two planes. They are accompanied by hints for fixing and studying the models, and with a useful list of problems suggested as exercises for students. The clearness of the explanations, the simplicity of the constructive apparatus, and the compactness of the arrangements (all being contained in a handy cardboard box) commend Mr. Jones's work to students of solid geometry.

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.*]

Lion-Tiger Hybrids.

I HAVE read Dr. Ball's account of this subject in the issue of NATURE for February 23, 1893, and beg leave to call attention to the fact that the University of Cambridge possesses the skeleton and the stuffed skin of an *adult* hybrid between a lion and a tigress. I am able to supply the following information (which I have verified so far as it was possible) with regard to this specimen from a contemporary MS., entitled "Notice of the Lion-tiger which died in Cambridge, March 1833," by J. B. Melson, then an Undergraduate at Trinity College. This MS. no doubt contains the substance of a paper by Mr. Melson, which was communicated by Dr. Haviland to the Cambridge Philosophical Society, May 6, 1833. The paper was unfortunately not printed in the Transactions of the Society.

The Cambridge specimen, like those mentioned by Dr. Ball, was procured from the menagerie of Mr. Atkins. It was about six years old, and for some time previous to its death had been affected with paralysis of its hind quarters, arising probably from a distortion of the lower thoracic region of the vertebral column [which is still a marked feature of the actual skeleton]. Although inferior in size to either of its parents, the animal appeared to have attained its full dimensions. The shape of the head resembled that of the father (the lion), whilst the form of the body was more similar to that of the tigress. The body was faintly striped, while the prevailing shade was "of a dingy lion colour." The animal had neither a mane nor a tuft at the end of its tail.

The specimen was a female, and Mr. Melson states that "all the individuals of this hybrid race have as yet been females." The orifice of the vagina was smaller than in the tigress; and the uterus was "merely rudimentary and nothing more than a membranous tube terminating in the two fallopian tubes." The ovaries were normal in appearance, though very much smaller than those of the full-grown lioness or tigress.

The extreme length of the skull, from the end of the occipital crest to the end of the præmaxillæ, of the specimen now in the Cambridge Museum, is 290 mm.; the distance between the foramen magnum and the end of the præmaxillæ is 235 mm.; and the extreme zygomatic breadth is 190 mm. The ascending process of the maxilla ends at a point 3 mm. in front of the posterior end of the nasal bones, and has a somewhat rounded termination. In these characters the skull of the hybrid resembles that of the lion much more closely than that of the tiger. S. F. HARMER.

University Museum of Zoology, Cambridge, February 27.

Travelling of Roots.

THE mode in which roots travel in pursuit of food (moisture) is often remarkable. Innumerable instances have been published. But I think the inclosed is one of the most striking which I have come across. The specimen kindly sent to the Kew Museum by the vicar of Petersham is most extraordinary. The roots seem to have behaved more like the mycelium of a fungus than an ordinary axial structure.

W. T. THISELTON-DYER.

Royal Gardens, Kew, Feb. 24.

Memorandum by the Rev. W. H. Oxley, Vicar of Petersham, dated February 16, 1893.

Roots of a Wistaria from the dining-room of Eden House, Ham, just demolished.

The root entered the room by a very small chink in the side of the window, near the ceiling, and on removing the paper, which had not been disturbed for many years, from the walls (of the room about 14ft. square) the whole of the plaster beneath the paper was found covered with a fine network of roots spreading all round the room. The specimen is about one-third of the whole roots and the stem where it entered the room. There was not the faintest appearance of anything of the sort on the surface of the wall paper to give rise to the suspicion of these roots being there, and the room was continually inhabited, with fires, &c.

The Flight of Birds.

WITH reference to an extract from *Science* on the flight of birds, which appeared in your "Notes" of February 16, I agree with the writer of that extract that the rapidity with which the generality of birds travel is often considerably over-estimated.

Some few months ago, whilst crossing, by G.W.R. express, the moors of Bridgewater Level in Somerset, a couple of turtle-doves rose at a distance of about eighty yards from the train, and flew for a considerable distance in a line nearly parallel with the rails.

I observed them with much interest, for I wished to have some comparison of their power of flight with that of some "homing" pigeons in my possession, and perceived that they were being slowly overtaken. They must have flown fairly parallel with the line of rails for at least 500 yards, and finally bore away northward. We must have been travelling at about forty miles an hour at the time, so that their speed would have been a little less than that. I was the more surprised at this as I had had "homing" pigeons, trained by myself, which, on a clear, calm day, had flown from the Quantock Hills to Taunton (a distance of seven miles) in less than eight minutes—a quite superior rate of flight, which, however, I do not think they would continue for a long distance. The Columbacei generally may be considered good flyers; the turtle, however, I believe from observation to be somewhat below the average standard of excellence. It certainly cannot be compared with the Passenger Pigeon of America, which has frequently been killed in the neighbourhood of New York with Carolina rice still undigested in its crop—having probably accomplished a journey of between 300 and 400 miles in about six hours, giving the high record of sixty miles an hour for six hours in succession. My own impression is that there is a great difference in the speeds of various orders and tribes of birds. I have repeatedly observed the fieldfare, which is a fairly strong flyer, overtaken by trains of which I have been an occupant, and which could not have been travelling more than forty miles an hour. On the other hand, I have witnessed the pursuit of a wood-pigeon or cushat by a hawk, in which both birds exhibited powers of flight which might seem incredible to persons unobservant of nature. In this instance I should have estimated the speed of the pigeon, which was straining every muscle to reach the shelter of a belt of timber, to be about sixty miles an hour; whilst that of the hawk, which flew with little effort, could not I think have been less than eighty, during the brief period that they were within my sight. I should be glad to hear from any of your correspondents their opinion as to the rapidity of flight in the Raptores (British). HERBERT WITHINGTON.

Taunton, February 22.

The Niagara Spray Clouds.

I DO not remember having seen anywhere a reference to the fact that the spray clouds of Niagara exhibit an ice bow in clear frosty weather.

I had an opportunity last week of seeing a very fine complete bow, the inner one, the outer being absent.

There was no trace of the mock suns or of the bands of white light usually present; though I have seen ice bows without the latter, I have never seen one before without any trace of mock suns; these are generally accounted for by supposing the presence of hexagonal ice prisms. I would suggest the inference that the ice crystals in the Niagara spray clouds are not prisms but rhombs. CHAS. A. CARUS-WILSON.

McGill University, Montreal, February 6.

British New Guinea.

IN NATURE (vol. xlvii. p. 345) Mr. H. O. Forbes has a lenient review of Mr. J. P. Thomson's "British New Guinea," in which he reproduces a figure of four natives. In the original they are called "native mountaineers" (p. 95). As a matter of fact only the two central men are mountaineers; the two outermost being coast natives who acted as decoys to induce the timid highlanders to submit to being photographed. Mr. Thomson has a reprehensible habit of inserting figures which, while they illustrate the contiguous text, really belong to a different part of British New Guinea than that there dealt with. I fancy Mr. Forbes has been deceived in this respect, for the last figure which appears in the review is entitled by Mr. Thomson "Native Ornaments" (p. 120), and, though occurring in his description of the Fly River district, represent, if I am not mistaken, Papuan Gulf natives, most probably Motu-Motuans. ALFRED C. HADDON.

I QUITE agree with Prof. Haddon's remarks above, which you have been good enough to submit to me, with regard to the mountaineers of the interior of New Guinea. They enter into details which, in an already over-long review, I had no space for. There is no doubt about the right-hand figure (p. 346) being *not* a mountaineer. I was less confident about the man on the left hand. The *two central figures* recall to me perfectly the people of Uburukara, of whom I took photographs in 1886, the plates of which were ruined during my disastrous march down the Goldie, and it was they who specially attracted my attention. With regard to the "Fly River" natives, I have never had the fortune to see any of them, but I certainly took the central figure to be one, while remarking to myself the likeness of the right-hand man to a Motuan—to men with whom he could be matched in any village indeed between the Gulf and Kerepunu.

104, Philbeach Gardens, S.W. HENRY O. FORBES.

Some Lake Basins in France.

I REGRET that, through some inadvertence on my part, the name of the author of the "Atlas des Lacs Français," mentioned in my letter (p. 341) is wrongly printed. It should be Delebecque. In a letter received from M. Delebecque, he informs me that "the direction of the arrow on the map of Lake Léman is not exactly N., but N. 7° W." He informs me also that the curious funnel-shaped hole at the northern end of the Lake of Annecy, which I suggest may be a submerged swallow-hole, is the site of a spring. This fact, however, need not be fatal to my suggestion, because the changes in level might convert what was once a swallow-hole into a spring. At present water at one time flows up from the dolinas of the Julian Alps, at another it drains off down them. T. G. BONNEY.

ON ELECTRIC SPARK PHOTOGRAPHS; OR, PHOTOGRAPHY OF FLYING BULLETS, &c., BY THE LIGHT OF THE ELECTRIC SPARK.[1]

I.

WHEN I was honoured by the invitation to deliver this lecture I felt some doubt as to my ability to find a subject which should be suitable, for there is a prevailing idea that in addressing the operative classes, it is necessary to speak only of some practical subject which bears immediately upon the most important industry of the place in which the lecture is being delivered; but it seems to me that this is a polite suggestion that the audience are unable to be interested by any subject except that particular one which occupies them daily. Now though I am a comparative stranger in Scotland I have heard quite enough, and I know quite enough, of the superiority of the education of you, who have the good fortune to live in this the most beautiful half of Great Britain, to be aware that, as is the case with all highly-educated men, you are able to take a keen and genuine interest in many subjects, and that I had better choose one to which I have specially devoted myself, if I do not wish to expose myself to the risk of being corrected. I will ask you therefore in imagination to leave your daily occupation and come with me into the physical laboratory, where, by the exercise of the art of the experimentalist, problems which might seem to be impossible are continually being solved. I wish as an experimentalist to present to you an example of experimental enquiry.

Let us suppose that for some reason we wish to examine carefully and accurately some moving object travelling, if you will, at so great a speed that, observed in the ordinary way, it appears as a mere blur, or perhaps at a speed so tremendous that it cannot be seen at all. In such a case, in order to get a clear view of the moving body we may either look through an aperture which is only opened for a moment as the body passes by, or we may suddenly illuminate the object by a flash of light when it is in a position in which it may be seen. If in either of these cases the hole is open, or the illumination lasts so short a time that the object has no time to move appreciably while it is in this way brought into view, we get what may in ordinary language be called an instantaneous impression and the object appears clear, sharp, and at rest. In the same way if we wish, with the object of obtaining a permanent record, to photograph a moving body we must either allow the eye of the camera to see through a hole for a moment, *i.e.* we must use a rapid shutter, and many such are well known, or we must, keeping the photographic plate exposed and the object in the dark, make a flash of light at the right time. As before, if the shutter is open or the flash lasts so short a time that the object cannot move appreciably in the time, then, if any impression is left at all it will be sharp, clear, and the same as if the body were at rest. The first method, that of the shutter, I do not intend to speak about to-night, but as, owing to the kindness of Mr. F. J. Smith, I have with me the most beautiful example that I have seen of what can be done by this method, I thought perhaps I should do well to show it. Mr. Smith was in an express train near Taunton, travelling at forty miles an hour, and when another express was coming up in the opposite direction at sixty miles an hour, *i.e.* approaching him at one hundred miles an hour, he aimed his camera at it and let a shutter of his own construction open and shut so quickly that the approaching train was photographed sharply. There is a special interest about this photograph; it shows one of the now extinct broad-gauge engines on the road. However, this is an example of the method which we shall not consider this evening.[2]

[1] Lecture delivered at the Edinburgh meeting of the British Association by C. V. Boys, F.R.S.

[2] I have heard that a cannon-ball has been photographed by means of a rapid-shutter, but I have no direct information on the subject.

For our purpose we require what is called instantaneous illumination,—a flash of light. It is of course obvious that it depends entirely upon the speed of the object and the sharpness required, whether any particular flash is instantaneous enough. No flash is absolutely instantaneous, though some may last a very short time.

For instance, a flash of burning magnesium powder lasts so short a time that it may be used for the purpose of portraiture, and while it lasts even the eye itself has no time to change. The lower part of the second slide (Fig. A) is a photograph of the eye of Mr.

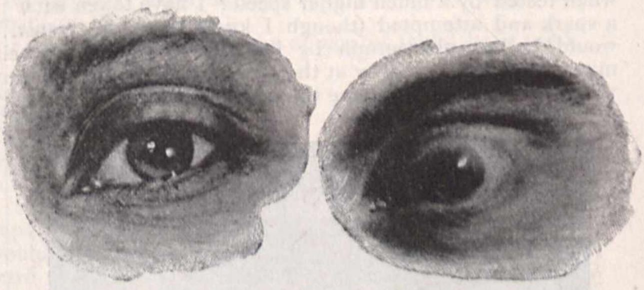


FIG. A.

Lower part. Upper part.

Colebrook after he had been some minutes in a dark room, taken by the magnesium flash; the upper part is the same eye taken in daylight. The pupil is seen fully dilated and the eyelid has not had time to come down, and so we might reasonably say that the flash was instantaneous; it was for the purpose practically instantaneous. Yet when I make this large clock-face four feet across revolve at so moderate a speed that the periphery is only travelling at forty miles an hour and illuminate it by a magnesium flash you see no figures or marks at all, only a blur. Thus the magnesium flash, which for one purpose is practically instantaneous, is, tested in this simple way, found to last a long time. Let me now, following Lord Rayleigh, contrast the effect of the magnesium flash with that of a powerful electric spark. At each spark the clock-face appears brilliantly illuminated and absolutely at rest and clear, and if it were not that I could at once illuminate it by ordinary light it would be difficult to believe that it was still in motion.

The electric spark has been often used to produce a flash by means of which phenomena have been observed which we ordinarily cannot see. For instance, Mr. Worthington has in this way seen and drawn the exact form of the splash produced by a falling drop of liquid.

Mr. Chichester Bell, Lord Rayleigh, Mr. F. J. Smith, and others have used the illumination produced by an electric spark to photograph phenomena which they were investigating. I am able to show one of Lord Rayleigh's, a breaking soap-bubble, in which the retreating edge, travelling something like thirty miles an hour, is seen with all the accuracy and sharpness that is possible with a stationary object. Mr. F. J. Smith has extended the use of sparks for the purpose of physiological enquiry, taking a row of photographs on a moving plate at intervals that can be arranged to suit the subject, and is thus putting in the hands of the much-abused experimental physiologist a very powerful weapon of research. I had hoped to show one of these series of an untechnical character, to wit, a series taken of a cat held by its four legs in an inverted position and allowed to drop. The cat, as every one is aware, seems to do that which is known to be dynamically impossible, namely, on being dropped upside down to turn round after being let go and to come down the right way up. The process can be followed by means of one of Mr. Smith's multiple spark photographs. However, his cats do not seem to like the experiments, and he has in consequence had so much trouble with them that his results, while they are of interest, are not, up to the present, suitable for exhibition.

Let me now return to single spark photographs. We have seen that the magnesium flash, which for the purpose of portraiture is practically instantaneous, yet fails to appear so when so moderate a speed as forty miles an hour (and indeed a far lower speed) is used for the purpose of examining it. Is anything of the kind true in the case of the electric spark? Will the spark, by which we saw the clock-face absolutely sharp, after all fail to give a sharp view when tested by a much higher speed? I have taken such a spark and attempted (though I knew what the result would be) to photograph by its light the bullet of a magazine rifle passing by at the rate of about 2100 feet a second, or, what is the same thing, at about 1400 miles an hour; the result (Fig. 1) shows not a clear sharp bullet but a blur; the spark lasted so long a time that this bullet was actually able to travel half an inch or so while the illumination lasted. Thus we see, that if we wish to examine bullets, &c., in their flight, any electric spark will not necessarily do. We shall have to get a spark which while it gives enough light to act on the plate yet lasts so short a time that even a rifle bullet cannot move an appreciable distance during the time that it is in existence.

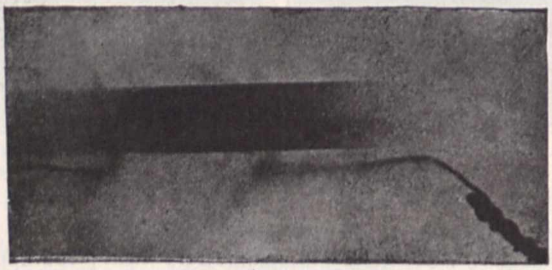


FIG. 1.

A knowledge of electrical principles enables one to modify the electrical apparatus employed to make this spark in such a manner that its duration may be greatly reduced without, at the same time, a very great sacrifice of light; but while this may be done it is important to be able to observe how long the spark actually lasts, when made by apparatus altered little by little in the proper manner. The desired information is at once given by the revolving mirror. For instance, every one is aware how, by a turn of the wrist, one may reflect a beam of sunlight from a piece of looking-glass so as to travel up the street at a most tremendous velocity; but suppose that, instead of being moved by a mere turn of the wrist, the mirror is made to rotate on an axle by mechanical means at an enormous speed; then, just as the rotation is more rapid, so will the beam of light travel at a higher speed. In the particular case that I am going now to bring before your notice, a small mirror of hardened steel was made by Mr. Colebrook, the mechanical assistant in the physical laboratory at South Kensington, mounted so beautifully that it would run at the enormous speed of 1000 turns a second (not 1000 a minute) without giving any trouble. The light from the spark was focussed by the mirror upon a photographic plate. Now if the light were really instantaneous, the image would be as clear and sharp as if the mirror were at rest; if, on the other hand, it lasted long enough for the image to be carried an appreciable distance, then the photograph would show a band of light drawn out to this distance. The mirror is now placed on the front of the platform, and a beam of electric light is focussed by it upon the screen, from which it is distant about 20 feet. Now that I turn the mirror slowly, you see the spot of light drawn out into a band reaching across the screen, and this is described over and over again as the mirror revolves. Let us suppose that the mirror is revolving once a second, then it is easy to show that the spot of light is travelling at about 250 feet a second. It is not difficult therefore to see that if the mirror is revolving 1000 times as fast, the spot of light will traverse the screen 1000 times as fast also, *i.e.*, about 250,000 feet a second, or 160,000 miles an hour—a speed which is 200 times as great as that of a Martini-Henry bullet, while such a bullet only travels 14 times as fast as an express train. You will see, then, that it is not difficult to observe how long a spark lasts when its image can be whirled along at such a speed as this. I have now started the electro-motor, and the mirror is turning more and more rapidly. Now it gives a musical note of the same pitch as that given by the tuning-fork I am bowing; it is therefore turning 512 times a second. It is now giving a higher note, *i.e.* it is turning faster and faster, until at last it gives the octave, at which time it is turning 1028 turns a second. The band of light on the screen is produced by a spot now travelling at a still higher speed than that which I have just mentioned. I had hoped to have shown with this apparatus the actual experiment of drawing out the apparently instantaneous flash of an electric spark into a band of light, but I found that while it was easy to show the experiment in a small room, the amount of light was not sufficient to be seen in a great room like this. I must therefore be content to show one or two of the photographs which were taken lately in the physical laboratory at South Kensington by two of the students, Mr. Edser and Mr. Stansfield, whom I now take the opportunity of thanking. The next slide shows the drawn-out band of a particular spark made between magnesium terminals by the discharge of a condenser of $2\frac{1}{2}$ square feet of window-glass, the spark being $\frac{1}{8}$ inch long. Below the drawn-out band I have drawn a scale of millionths of a second. If the spark had been instantaneous it would have appeared as a fine vertical line. This line, however, has been drawn sideways to an extent depending on the duration of the spark. The spark, except at the ends, is extinct in rather less than one-millionth of a second, but the ends remain alight like two stars, being drawn out in consequence into two lines, which have lasted, as measured by the scale, as long as six or seven millionths of a second. Such a light is, therefore, seen to last when tested with this very powerful instrument so long that it seems absurd to call it instantaneous. It lasts too long for the purpose of bullet photography. In order to get sparks of shorter duration it is necessary to abolish the metal magnesium, in spite of the brilliant photographic effect of the two ends of the spark between knobs of this material, it is well to avoid all easily volatile metals, such as brass, because of the zinc that it contains, and instead to employ beads of copper or of platinum. In the second place, the duration of the spark proper, which in the last case was nearly a millionth of a second, can be reduced by (1) reducing the size of the condenser, but one must not go too far, as the light is reduced also; (2) by replacing any wire through which the discharge may have taken place by broad bands of copper as short as possible, this has the further advantage of increasing the light; and (3) the light may be increased without much change being made in the duration by making a second gap in the discharge circuit, the spark in which, however, must be hidden from the plate. Fig. 2 shows the trail of the best spark for the purpose of bullet

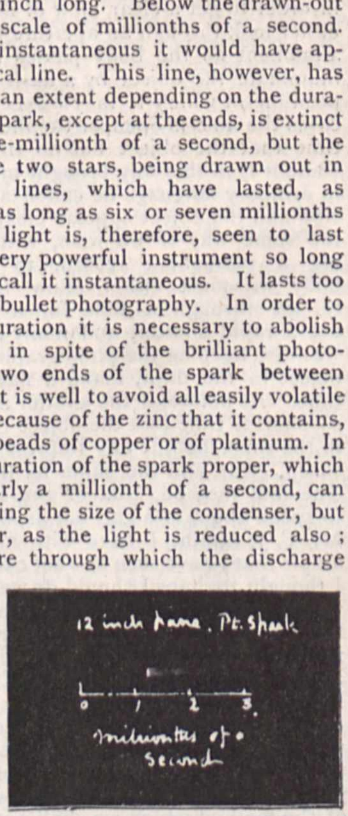


FIG. 2.

photography that I have obtained up to the present. In this case the surface of the condenser is one square foot, and the discharge is taken through bands of copper about two inches broad, and not more than about four inches long apiece. Extra good contact is made between these copper bands and the tin-foil surface by long radiating tongues of copper-foil soldered to the end of the copper bands. The knobs are platinum, but this seems no better than copper. The whole of the light is extinct in less than one-millionth of a second, while the first blaze, which is practically the whole spark, the tail being in comparison of no consequence, does not last so long as a ten-millionth of a second; in other words, it lasts so short a time that it bears the same relation to one second that one second bears to four months; or again, a magazine rifle bullet, travelling at the enormous speed that is now attained by the use of this weapon, cannot go more than one four-hundredth of an inch in this time. Other sparks of still less duration were examined, but this was chosen for the purpose of photographing bullets.[1]

Now, having obtained a suitable flash of light, I must next show how a spark may be used for the purpose of photographing a bullet in its passage. This was first done by Prof. E. Mach,[2] of Prague, whose method is illustrated by the diagram Fig. 3. The squares on the

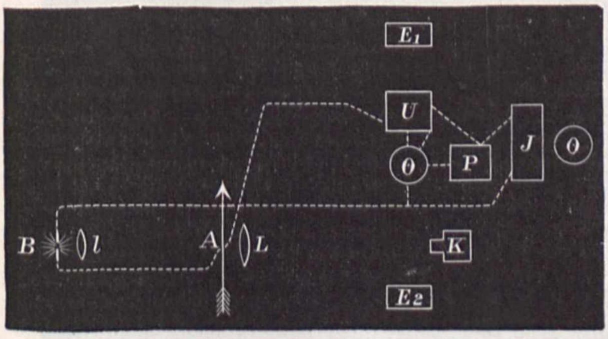


FIG. 3.

right-hand side represent certain electrical apparatus by means of which a Leyden jar (J) is charged with electricity to such an extent that, while it is unable to make two sparks at B and A, it is nevertheless able to, and at once will, make a spark at B when the second gap at A is closed by a bullet or other conductor. The dotted lines represent wires through which the discharge then takes place. The spark at B, magnified by the lens *l* in front of it, then fills the field lens L with light, so that the camera K focussed upon the spark gap A will then receive an image of the bullet as it passes, and thus a photograph is secured. I am able to show two of these which Prof. Mach has kindly forwarded to me, and what I wish to point out is that in each of these photographs—and this is perhaps the most interesting feature which any of these exhibit—there are seen, besides the bullet and the wires which the bullet strikes in its journey, certain curious shades, one in advance of the bullet and one from the tail, while a trail is left behind very like that seen in the wake of a screw steamer. In fact, the whole atmospheric phenomenon accompanying the bullet is not unlike that seen on the surface of water surrounding and behind a steamship. These were seen for the first time, and their visibility by this method was, I believe, predicted by Prof. Mach before he made his first experiment.

The part that I have played in this matter is after all very subordinate. I have attempted to simplify the means, and the results which may be obtained by the modified method which I have devised, are, I believe, in some respects—I don't say in all—clearer and more instructive than those obtained by the more elaborate device of Prof. Mach.

Fig. 4 is a diagram of the apparatus that I have used. C is a plate of window-glass with a square foot of tin-foil on either side. This condenser is charged until its potential is not sufficient to make a spark at each of the gaps E and E′, though it would, if either of these were made to conduct, immediately cause a spark to form at the other. *c* is a Leyden jar of very small capacity connected with C by wire, as shown by the continuous lines, and by string wetted with a solution of chloride of calcium, as shown by the dotted line. So long as the gap at B is open this little condenser, which is kept at the same potential as the large condenser by means of the wire and wet string, is similarly unable to make sparks both at B and E′, but it could, if B were closed, at once discharge at E′. Now suppose the bullet to join the wires at B, a minute spark is made at B and at E′ by the discharge of *c*, immediately C, finding one of its gaps E′ in a conducting state, discharges at E, making a brilliant spark, which casts a shadow of the bullet, &c., upon the photographic plate P. Though this is simple enough, the ends that are gained by this contrivance are not so obvious. In the first place the discharge circuit of C, via E and E′ is made of very short broad bands of copper, a form which favours both the brilliancy and the shortness of duration of the sparks; further, the double gap, of which E′ may be the longer, causes the intensity of the light of either spark to be greater than it would be if the other one did not exist—in a particular case the light of the shorter was increased six or eightfold—at the same time the duration is not greatly affected. For this reason the spark at E may be made very short, so that the shadow is almost as sharp as if the light came from a point. The spark formed at B, which is due to the discharge of *c* only, is very feeble, so that it is unable to act on the plate, whereas, had the discharge of C been carried round by B, the light at this point would hopelessly have spoilt the plate, and at the same time the light at E would have been feebler and would have lasted longer.

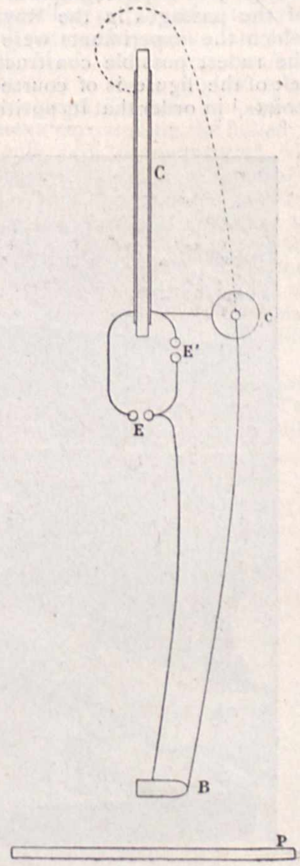


FIG. 4.

[1] These sparks were made to go off at the time that the mirror was facing towards the photographic plate by the employment of the same device as that described below in connection with Fig. 4. On the axle of the mirror an insulated tail of aluminium was secured, so as nearly to bridge a gap in the discharge circuit of an auxiliary jar of small capacity, there being a gap common to both circuits. A self-induction coil was used instead of the wet string, as being for this purpose preferable. The length of time that the spark lasted was thus measured without taking the electricity round by the mirror, which would have been quite sufficient to modify the duration of the discharge, and it was easier than making and adjusting a second reflecting mirror, which would have answered the same purpose.

[2] See NATURE, vol. xlii. p. 250.

The wet string, while it is for the purpose of keeping the condenser c charged a perfect conductor, is nevertheless, when this discharges at E′ and B, practically a perfect insulator; if it were replaced by wire then C would also wholly or partially discharge itself by B and E′. Finally, in avoiding all lenses one is free from the considerable absorption of the more refrangible rays which sparks provide in great abundance, and which are largely absorbed by glass. On the other hand the photograph is a mere shadow, but this is no drawback, for the bullet itself is on either system a mere silhouette, whereas the atmospheric phenomena are more sharply defined, and their character is more clearly indicated without lenses than is possible when they are employed.

Fig. 5 is a photograph of the apparatus set up in one of the passages in the Royal College of Science, in which the experiments were made. It is apparently of the rudest possible construction. The rifle seen on the left of the figure is of course made to rest freely on six points,[1] in order that its position every time it is fired may be the same. The bullet then traverses precisely the same course, so that wires placed in the line between holes in two cards made by one shot will be hit by the next. The two wires which the bullet joins as it passes by are set up in the box seen in the middle of the figure with the lid propped up so as to show the interior. The photographic plate is on the left-hand side and the spark when made is just within the rectangular prolongation on the right-hand side. Paper tubes with paper ends are placed on each side of the box to allow the bullet to enter and leave, and yet not permit any daylight to fall directly on the plate. All is black inside, and so the small amount of light which does enter the box through these holes is not diffused in any harmful manner. The large box at the back is a case 5 ft. long, filled with bran which stops the bullets gently without marking them. The little condenser is just below the rectangular prolongation of the photographic box, the large condenser is the vertical square sheet seen just to the right. The electrical machine used to charge the condensers is seen on the table. It is a very beautiful 12-plate Wimshurst machine made by Mr. Wimshurst and presented to the Physical Laboratory. This machine not only works with certainty but is so regular in its working that no electrometric apparatus is necessary. All that has to be done is to count the number of turns of the handle which are required to produce the sparks at E and E′ when the gap at B is not joined, and to count the number which are sufficient to produce a spark at E when the gap at B is suddenly closed. Then if the rifle is fired after any number of turns between these, but by preference nearer the larger than the smaller number, the potential will be right, the spark E, inside the box, and the spark E′, which is in sight outside the box, will be let off, and if a plate is exposed a photograph will be taken. If by chance the E′ spark is not seen then there is no occasion to waste the plate, another bullet may be fired after resetting the wires and the result will be as good as if one shot had not failed. When all is in order a failure of this kind is very rare. I also arranged a tube in the side of the box with a pocket telescope fixed in it and focussed on the wires. If a piece of white card or paper is placed in the line of vision and so as to be illuminated by a spark let off as above described but preferably much nearer the card, the bullet will be seen by any one looking through the telescope. I took this down, however, at once, as the photograph showed more than could ever be seen by the eye. The box seen just to the right of the rifle with a coil of wire upon it is the one in which the revolving mirror was fixed, and in which the trails of sparks made near the door at the end of the passage were photographed. The apparatus for photographing

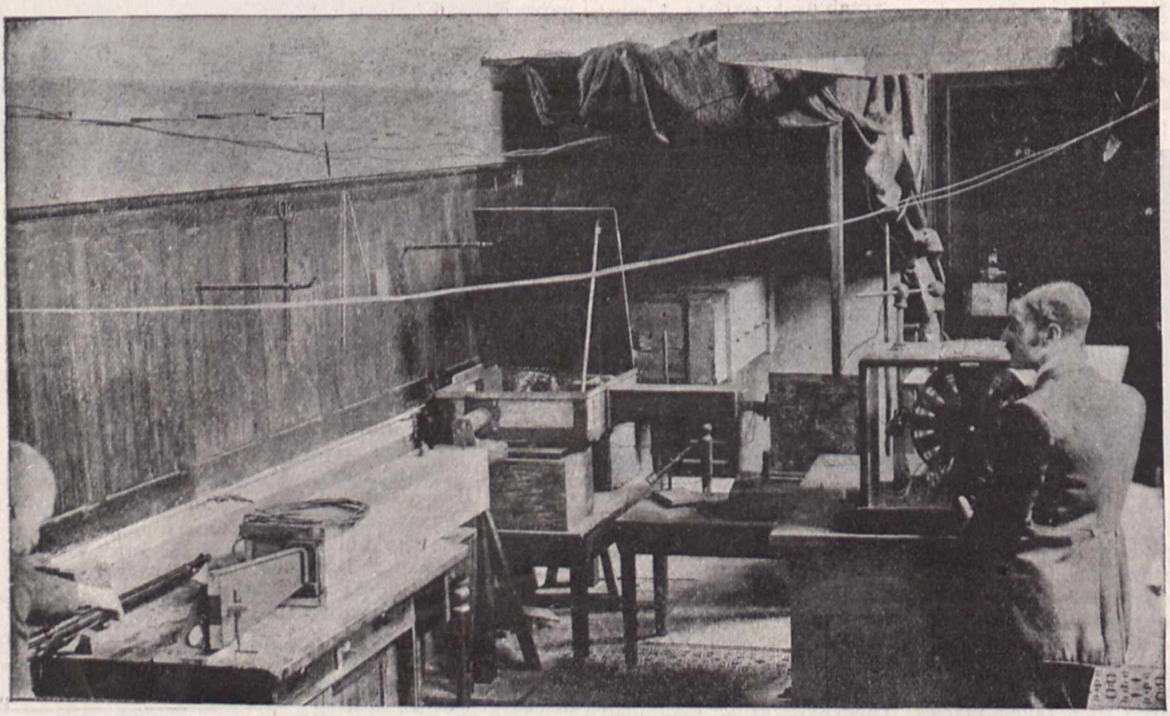


FIG. 5.

[1] Six independent points of support are required for a geometrical clamp. In this case a V support near the muzzle supplied two, a V support near the breach two more points, the rifle was pressed forward until a projection under the muzzle rested against the front V, thus allowing freedom of recoil, but otherwise preventing all uncertainty of position except that due to rotation in the V's which is made impossible by the sixth point, that is, the lower end of the stock resting sideways against a leather covered wooden bracket fastened to the same table to which the V's were attached.

the bullets was put together and set up by Mr. Barton, a student, whose very skilful help in the matter and afterwards during the experiments I found of very great value.

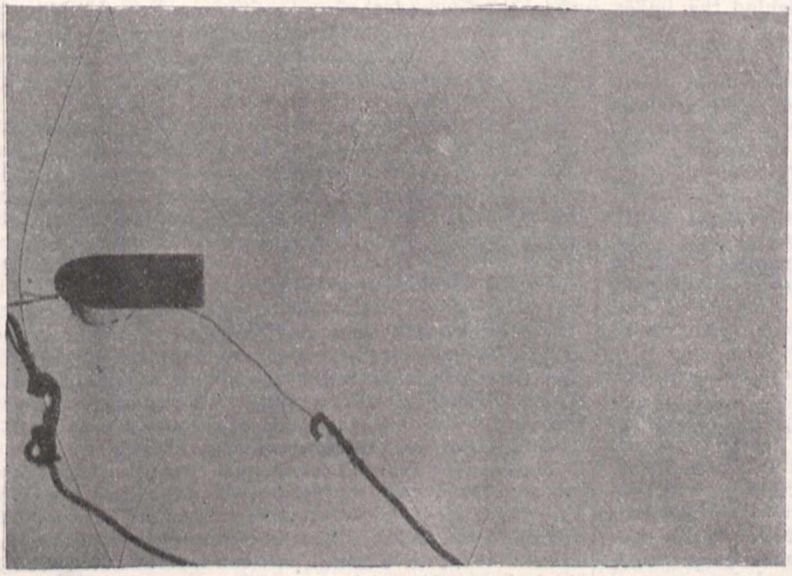


FIG. 6.

The first photograph which I am able to show was taken at Christmas, before the apparatus just described was put together. It was taken to see if the idea would practically succeed, merely using for the purpose bits of wire and other things to be found in any laboratory, which were set up in a dark room in less than an hour. The first shot was successful, but the sharpness of the photograph is not what it might be, owing to the fact that I used, for the sake of the brilliant light, a spark taken between magnesium terminals. However, the bullet is clearly enough defined, as are the wires which it has just struck. This is a photograph of a pistol bullet travelling only 750 feet a second. You will notice that unlike that taken by Prof. Mach, which represented a shot going at a much higher speed, this photograph shows no atmospheric phenomena surrounding the bullet. I would only add, in connection with this photograph, that by some accident the wad remained attached to the bullet in this case forming the enlarged tail. I do not know if this often happens; it must, if it does, seriously disturb the flight of the projectile, and introduce an anomaly that might not easily be accounted for.

The next photograph, Fig. 6, shows a bullet which has just left a Martini-Henry rifle. This is taken with the apparatus in its latest form, and the bullet appears perfectly sharp. There is no sign of any movement whatever in so far as the bullet itself is concerned.

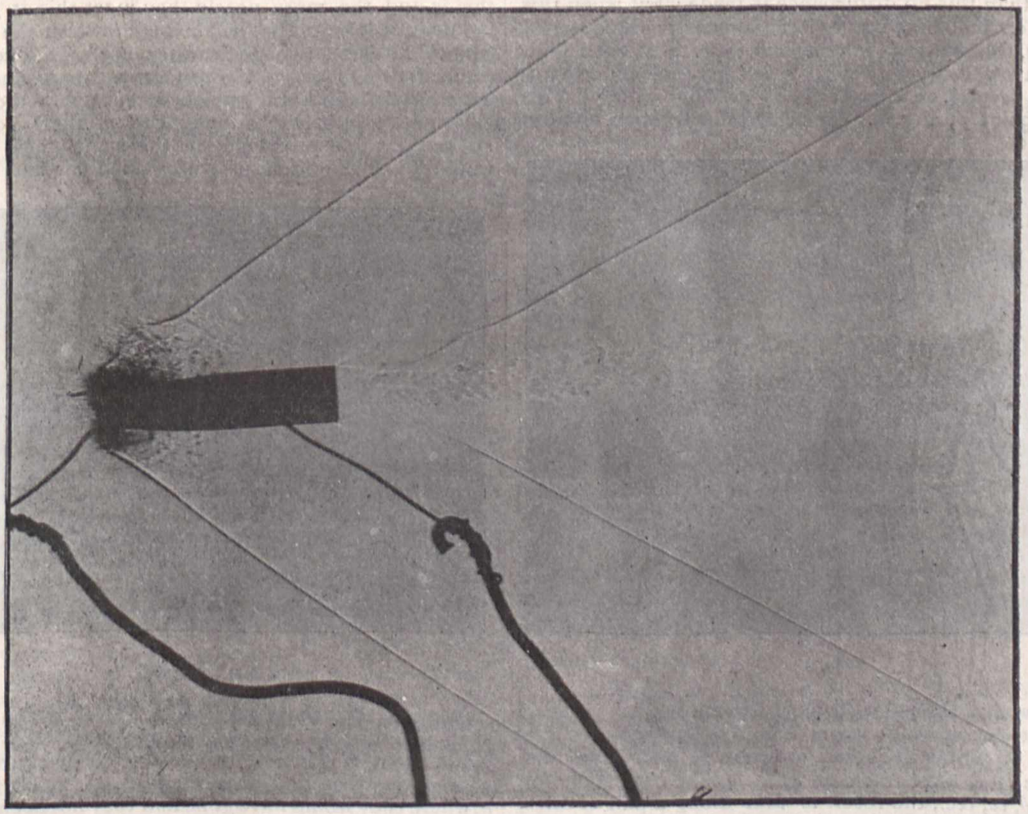


FIG. 7.

But now that we are dealing with a higher speed, namely, 1295 feet a second, there is evidence of the movement of the bullet in the form of a wave of compressed air in front and of other waves at the side of and behind the bullet. I shall explain this in a moment, but I would rather first show another photograph, Fig. 7, of a bullet travelling at a still higher speed, a magazine rifle bullet travelling about 2000 feet a second, in which these air waves are still more conspicuous, and in which a glance is sufficient to make it evident that the waves are much more inclined to the vertical than in the previous case.

Now as it may not be evident why these waves of air are formed, why their inclination varies with the speed, or why existing they are visible at all, a short explanation may not be out of place, more especially as they form the most interesting feature in the remaining photographs that I have to exhibit, which cannot, as a matter of fact, be properly interpreted without frequent reference to them.

I would first ask you to examine some still water into which a needle held vertically is allowed to dip. If you move the needle very slowly not a ripple is formed on the surface of the water; but as the needle is moved more quickly at first a speed is reached at which feeble waves appear, and then as the speed increases a swallow-tail pattern appears, the angle between the two tails become less as the velocity gets higher. Now in the case of water-waves the velocity with which they travel depends on the distance between one and the next, and for a reason into which I must not now enter either very long or very short waves travel more quickly than waves of moderate dimensions. If they are about two-thirds of an inch long they travel most slowly—about 9 inches a second. Now so long as the needle is travelling less quickly than this no disturbance is made; but when this speed is exceeded the swallow-tail appears. Suppose, for example, the velocity of the needle to be double the minimum wave velocity for water, *i.e.* let the needle move at 18 inches a second, and let it at any moment have arrived at the point *p*, Fig. 8. Then any disturbance, started

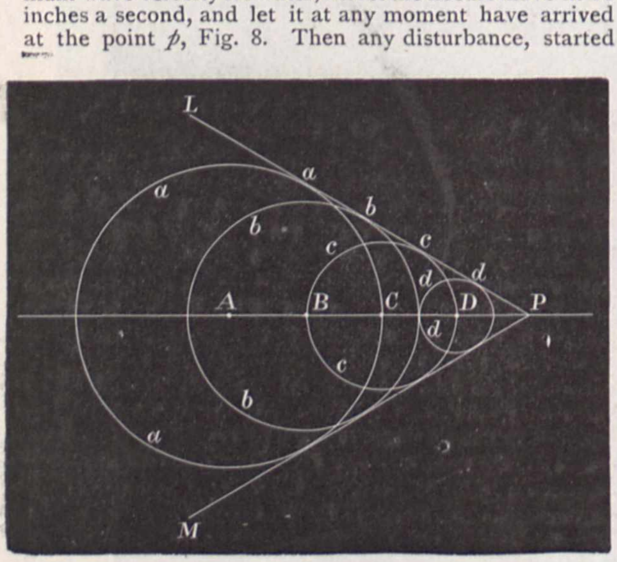


FIG. 8.

when it was at the point A, must have travelled as far as the circle *aaa* in which A*a* is half A*p*, similarly for any number of points BC, &c., between A and *p* any disturbance must have travelled as far as the corresponding circles *bb*, *cc*, &c., the result is that along a pair of lines, *p*L, *p*M, touching all the circles that could be drawn in this way, a wave will be found, and it is clear that as the velocity of the point is made greater the successive radii A*a* B*b*, &c., will become in proportion to A*p* less, the circles will be smaller, and the angle between L*p* and M*p* will become less, while when the velocity is made less the reverse happens, until at last A*a* B*b*, &c. = A*p* B*p*, &c., and then when they exceed these quantities no lines L*p* M*p* can be drawn touching all these circles, there is no wave surface which the disturbances from all the successive points can conspire to produce, and the consequence is there is still water.

Now consider the case of a bullet moving through the air. Here again we are dealing with a case in which a wave cannot travel at less than a certain speed which is obviously the velocity of sound (1100 feet a second under ordinary circumstances), but, as in the case of surface waves on water, higher speeds are possible when the wave is one of very great intensity. The conditions in the two cases are therefore very nearly parallel; if the bullet is travelling at less than the minimum speed no waves should be formed—the pistol bullet at 750 feet a second did not show any—if the bullet is travelling at higher speeds than 1100 feet a second waves should be formed which should include a sharper angle as the speed is made to increase. This was found to be so in the case of the Martini-Henry and the magazine rifle bullet.

The curved form of the wave near the apex is due to the fact that when it is very intense, when the compression is very great, the velocity of travel is greater and, immediately in front of the bullet, the air is compressed to so great an exent that the wave at this part can travel at the speed of the bullet itself.

The reason why the waves should be visible at all is not difficult to follow. Consider a shell of compressed air though which rays of light from a point are made to traverse. These rays travel in straight lines, except where they meet a medium of different density, and the denser this is and the more nearly they meet this at a grazing incidence the more they will be bent towards the perpendicular. In comparison with water or glass a layer of compressed air has very little refractive power, and so rays which strike the shell anywhere except at the extreme edge are practically uninfluenced in their course and strike the plate practically in the same place that they would do if the shell of compressed air had not been

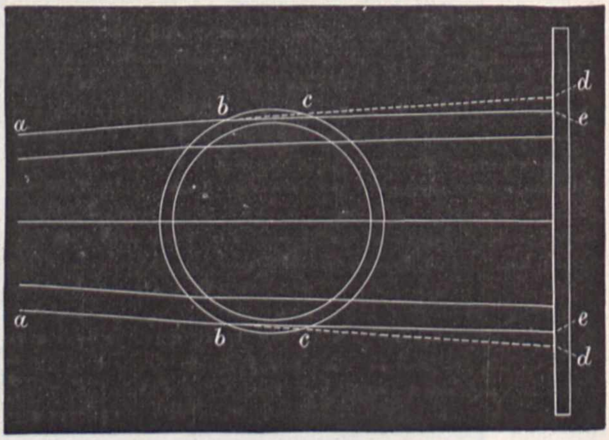


FIG. 9.

traversed. But those rays *ab*, *ab*, Fig. 9, which strike the shell of air almost tangentially are bent inwards slightly at *b* and again at *c*, having traversed what is equivalent to a wide angle prism, and strike the plate at *e*, leaving the place *d*, where they would have gone had they not been refracted, dark; moreover at *e* they meet other rays which have been hardly at all refracted since they have passed actually into the shell and out again, and therefore *e* is doubly illuminated. The consequence is that a wave or shell of compressed air gives rise to an image on the plate, in which there is a dark line and a light line within it. Similarly a wave of rarefaction must produce a light line with a dark one within it.[1] An examination of the photograph Fig. 7 will make it evident that not only is the head wave a wave of compression, but the wave, which starts from the end of a kind of vena contracta behind the bullet, is also a wave of compression. It is a curious fact which requires explanation that the head and tail waves are not parallel to one another, and they do not show any sign that they would become parallel if they were continued indefinitely. This can only be due to either the tail of the bullet travelling considerably faster than the head, or to the actual velocity of propagation of the tail wave being less than that of the head wave. The effect observed is true and is not optical, being neither due to the refractive effect of the outer shell disturbing rays which are tangential to the inner shell, nor to an effect of perspective, for though the projection of a cone from a point upon a plane is only seen of the proper angle, when the perpendicular, dropped from the point upon the plane, passes through the vertex of the cone, yet when, as in the case of Fig. 11, where it passes within both cones, and more within the outer one than the inner one, the effect is to make the projections of both of a greater obtuseness, and of the outer one to a greater extent than the inner one; nevertheless an examination of the amount of this effect of perspective made by Mr. Barton showed that the distortion was not sufficient to be noticeable, as the difference in the acuteness of the cones certainly is.

(To be continued.)

NOTES.

ADMISSION to the Croonian Lecture, which Prof. Virchow, as we have already announced, is to deliver before the Royal Society at 4.30 p.m. on the 16th inst., will be by ticket, which may be obtained from the assistant secretary by introduction of a Fellow of the Society.

THERE will be widespread regret at the announcement which we now make that the distinguished geologist, Prof. K. A. Lossen, of Berlin, died there on the 24th ult. He had been ailing for some time, and suffered severely before he entered into his rest. In spite of the deafness which necessarily restricted his intercourse with men of science, he had formed a wide circle of friends who learned to appreciate the simplicity, candour, and geniality of his character, while at the same time they came to respect and admire more and more his wide range of knowledge, and that marvellous and apparently intuitive perception of the true characters of rocks which made him probably the best field-petrographer in Germany.

WE have received news of the death of Cav. Giuseppe Antonio Pasquale, for many years professor of botany in the University of Naples, and director of the botanic garden. Prof. Pasquale was the author of numerous articles on botany and cognate subjects. His earliest works of which we have cognisance were on the flora of Capri (1840), and the flora of Vesuvius (1842). In 1869 he published a more complete "Flora Vesuviana, confronte con quella dell' isola di Capri." He appears to have been appointed to the post of director of the Naples Botanic Garden in 1866, and the following year he published a catalogue of the plants cultivated there, together with a brief history of the garden.

THE German Government has established a biological Institute on the island of Heligoland, and has appointed Dr. Kuckuck its botanical director.

PROF. SCHWEINFURTH landed at Port Said on January 7, for an expedition into Upper Egypt which is intended to extend over several months. Dr. D. Riva, who accompanied Schweinfurth on his last journey, has undertaken an expedition to Eastern Africa in the vicinity of the river Giuba.

THE moss-herbarium of Dr. Rehmann and the Hepaticæ-herbarium of Dr. Gottsche have passed into the possession of the Botanical Museum of Berlin; the Botanical Museum of the University of Vienna has acquired the moss-herbarium of Hoppe; and the Botanical Institute of the German University at Prague the greater part of the valuable library of Prof. Willkomm.

THE Reale Istituto Veneto di Scienze, lettere ed arti proposes the following prize subjects:—(1) A lithological, mineralogical, and chemical investigation of the rocky, sandy, earthy, and saline materials brought down under various conditions by one of the chief rivers of Venetia from the Alpine valleys, and deposited at various distances from the base of the Alps to the sea (prize, 3000 lire, date December 31, 1893). (2) A compendium of the history of mathematics, with a mathematical chrestomathy containing extracts from mathematical works of antiquity, the middle ages, the renaissance, and recent times down to Gauss (indicating in each case the reason for introducing the extracts), (prize and date the same). Papers may be written in Italian, Latin, French, German, or English, and are to be sent in to the secretary with motto and sealed packet.

SIR ANDREW BARCLAY WALKER, who died on Monday, did much to promote intellectual life in Liverpool. The University College of that city has good reason to remember him as one of its most generous benefactors. He assumed the entire pecuniary responsibility for the erection of the Walker engineering laboratories, which cost about £20,000.

MR. O. M. EDWARDS, who was appointed to investigate the various conditions which have to be taken into account in connection with the proposal for the establishment of a Welsh University, has completed his inquiries and forwarded his report to the Vice-President of the Committee of Council on Education. A writer in the *University Correspondent* says the report is practically a pamphlet of about eighteen octavo pages, containing a short account of the origin and progress of the educational movement in Wales, and intended to supplement the information already possessed by the Department of Education on this head. It contains a succinct epitome of the various schemes proposed—the Shrewsbury Charter, the proposals of Dr. Roberts and Prof. Evans; gives the state of efficiency of Lampeter and the three Welsh colleges; contrasts them with those at Leeds and Manchester; and points out how far, more or less, the Welsh institutions are prepared and adapted, in point of staff, students, accommodation, and appliances, to receive similar powers.

THE Municipal Council of Paris has been giving names to some new streets, and changing those by which various old streets have hitherto been known. The names selected for use are for the most part those of illustrious Frenchmen, and it is significant that among them are some well-known men of science. The Rue du Battoir, for instance, is henceforth to be called the Rue Quatrefages, in memory of the famous anthropologist; and the Rue Claude-Vellefaux becomes the Rue Charles-Robin, in memory of the great physician. A new street is called after

[1] It may be worth while to point out that the dark and light lines are, and ought to be, parallel to one another as soon as they are so far away from the shadow of the bullet as to be practically straight lines. For if the thickness of the shell is divided up into a series of elements the ray passing through any one of these will meet with a refractive medium, which is less effective as the diameter of the part of the shell considered is greater, while the refractive angles of the elementary prisms become inclined more so as to compensate for the diminished density.

Ernest Renan. This is only one of many indications of the respect in which science is held in France. We shall probably have to wait some time before it is decided by the municipal authorities of London that streets shall be known by the names, say, of Darwin and Joule.

THE atmospheric disturbance referred to in our last issue as crossing this country on Tuesday, February 21, reached the English Channel on the following day; afterwards its progress eastwards was unusually slow, and north-west winds belonging to the rear of the disturbance were experienced. Frost occurred during the night of the 22nd in many parts, and towards the close of last week the daily maxima fell below 40°, except in the extreme west and south-west, while in the midland counties frost continued throughout the day, and hail and snow occurred in many places. After a temporary improvement in the south and south-east districts on Saturday, a deep depression reached our south-west coasts from the Atlantic, causing strong gales on Sunday, and very severe snowstorms in Scotland, with heavy rain in other parts of the country, the fall exceeding an inch and a quarter on the north-east coast. By Sunday evening the disturbance had reached the north-east of England, where the barometer had fallen to 28·6 inches; this depression was preceded by severe frost in Scotland, the minimum temperature recorded at Nairn being as low as 11°. On Monday a north-westerly gale was blowing in Scotland, accompanied by snow, and on the same day a new depression arrived over the south-west of England, accompanied with further heavy rainfall in the southern half of the kingdom, and strong winds and gales in the English Channel; frost also occurred in many parts. After these gales had subsided, the weather still remained in a very disturbed and unsettled condition. The *Weekly Weather Report* issued on February 25 showed that the temperature for that week was generally 1° to 2° below the mean in Great Britain, and 3° to 4° below in Ireland; also that the rainfall was much in excess of the average in the southern and eastern parts of England.

THE Report of the Meteorological Council for the year ending March 31, 1892, just presented to Parliament, reviews the work of the office under four heads: (1) *Ocean Meteorology*. The charts for the Red Sea were in an advanced state, and the extraction of data for the current charts of the Atlantic, Pacific, and Indian Oceans, and of data referring to the southern ocean, was being actively carried on. In this branch of the work the supply of instruments to ships is supplemented by the supplies to remote stations, when favourable opportunities occur. (2) *Weather Telegraphy and Forecasts*. An important station has been established at the North Foreland, and the work generally in this branch continues to increase; both the Daily and Weekly Weather Reports have been extended and improved. Weather forecasts are prepared three times daily; the total percentage of success of the 8h. 30m. p.m. forecasts which appear in the morning newspapers was 80, being 2 lower than in 1890-91. The results were best in England south, and worst in Scotland west. The percentage of success of the forecasts issued during haymaking was 89 per cent. Although these forecasts are issued solely for the benefit of farmers, the Agricultural Department does not at present aid in their dissemination. (3) *Land Meteorology of the British Isles*. Under this head are included all observatories, anemograph stations, and volunteer stations, necessary for the study of the periodic variations of the meteorological elements, and of climatology. Among the publications we may specially mention the "Harmonic Analysis of the Hourly Observations at British Observatories," which is probably the first systematic publication of the description that has hitherto been brought out by any of the established meteorological institutions. (4) *Miscellaneous*. This head gives an account of the various researches now in hand, among which are included investigations relating to rainfall, sunshine, fog, &c. It also contains particulars relating to the work done in cataloguing books and pamphlets, and also a classified summary of expenditure. A special note contains an account of the anemometer comparisons carried out by Mr. W. H. Dines, with the aid of a grant from the Council.

THE Meteorological Council have just issued a summary of the *Weekly Weather Report*, 1892, containing, among much other information of importance to agricultural and hygienic meteorology, an appendix showing the rainfall and mean temperature for the 27 years 1866 to 1892, for each of the 12 districts into which the United Kingdom is divided for the purpose of weather forecasts. The values show that the average rainfall for the whole of the British Islands is 34·9 inches; in the wheat-producing districts the average fall for the year is 28·2 inches, while for the grazing, &c., districts it is 41·6 inches. The wettest district is the west of Scotland, where the average annual rainfall is 45·5 inches, and the driest is the east of England, where the average amount is 25·8 inches. The values for the year 1892 varied considerably in different localities; the wettest district during the year was the north of Scotland, where the fall was 5·6 inches in excess of the average, while in the south-west of England the deficiency was 12·5 inches. As regards temperature, the average for the whole area for the 27 years (omitting the Channel Islands) was 48°·4, and the mean difference of temperature between the wheat-producing and grazing districts scarcely amounted to a degree. The average value for the whole area during 1892 was 1°·6 below the mean for the 27 years; there was a deficiency in every district during that year, the greatest amount being 2°·3 in the east of Scotland, and the least, 0°·9 in the south of England; in fact, it was the coldest year experienced since 1879.

AN electrical actinometer was used by Messrs. Elster and Geitel, of Wolfenbüttel, in their measurements of the sun's ultraviolet radiation. The instrument, as described in *Wiedemann's Annalen*, was based upon the action of ultraviolet light in accelerating the dissipation of an electric charge from a cathode of amalgamated zinc. By exposing a plate of the metal to the light from a stream of sparks from an induction coil at various distances, and determining the dissipation of a negative charge imparted to it, this was proved to be a linear function of the light intensity. In its portable form the instrument consists of a cylinder which can be directed towards the sun, and into which a charged sphere of amalgamated zinc is introduced by means of an insulating handle. The fall of potential during a few seconds' exposure is determined by means of an Exner electroscope. Messrs. Elster and Geitel have made observations for each month in the year, and found the ultraviolet radiation to exhibit an inverse relation to atmospheric electricity. Comparisons were also made of the results at various heights above the sea-level, the stations being the summit of the Sonnblick (3100 m.), Kolm-Saigurn, in the adjoining valley (1600 m.), and Wolfenbüttel (80 m.). It was found that 40 per cent. of perpendicular ultraviolet rays from space reached the level of Sonnblick, 23 per cent. of these were absorbed before reaching the next station, and only 47 per cent. of the remainder arrived at the level of Wolfenbüttel.

TEN years ago there was some correspondence in NATURE on the subject of snow-rollers. The phenomenon does not seem to occur very often, so that some interest attaches to a communication in *Science* (February 3), describing an instance noted last year at Milledgeville, Ohio. Mr. W. S. Ford says that on the morning of January 30, 1892, the clean level fields surrounding that town were covered with balls of snow, varying in size from three to five inches long and from one to two inches wide.

Wheat-fields and meadows abounded with these balls, and suggested, at first sight, that a troop of school-boys had been having a battle with the snow. Two fields, of thirty acres each, that came under Mr. Ford's observation (one a new-sown wheat-field and the other a meadow) were literally covered with these "snow-rollers," there being at least 500 on the acre. Road-sides and lots contained a few, and he noticed them on house-tops and straw-ricks. On close investigation, he found the balls to be uniformly light and fragile, so that to lift one and preserve its form was impossible. Some were oblong, some almost spherical, while others resembled a tea-cup or small bowl. There were no tracks behind them, or, if these had been made, the falling snow had obliterated them. The accompanying weather conditions were as follows:—The ground had been covered with snow for three weeks. A crust had formed on the top, thick and firm enough in places to bear up a person. This thawed a little during the afternoon of the 29th. The ensuing night was warm, the mercury registering 40° F. By ten o'clock a brisk wind was blowing, which increased in velocity, and soon the snow began to fall in large, moist flakes. The morning showed that about a half-inch had fallen on the crust, and on this lay the balls. The phenomenon was reported from several places in the vicinity, chiefly in the Fayette County, and from Clinton County, which adjoins it on the west, but nowhere did the rollers extend uninterruptedly over any great area.

IN November last, according to a writer in the Journal of the Straits Branch of the Royal Asiatic Society, there was in Singapore one of the largest specimens of the Mias or Orang-Utan ever captured; it was a male, and probably of the species known as *Simia satyrus*, Linn., or the Mias Pappan of the Dyaks. The animal was captured in Borneo, and bought by a native dealer in Singapore, who eventually sold him to a German ship's captain, by whom he has been, it is believed, taken to Germany. As far as the writer could judge, his height must have been close on 4 feet 5 inches. The cage in which he was confined was 4 feet 2 inches or thereabouts in height, and he could easily touch the top of it with his head without standing erect. His face was immensely broad, the cheeks being flattened out sideways into a sort of disc. The hair was long (about 4 inches) and thick and of a bright red colour, and he had a distinct short pointed beard. The eyes were dark brown.

A WRITER who signs himself "Tutuila" contributes to the current number of the Journal of the Polynesian Society some interesting notes on the races known as the Tokelaus, or Line Islanders, called by themselves the Kai-n-Abara, which means "people of our land." The Kai-n-Abara inhabit all the islands of the Gilbert Group, Nanumea, and Nanumanga in the Ellice Group, and Banapa or Ocean Island. They are apparently of the Micronesian type, but although they have long straight hair, and are more of a copper colour than brown, they are not pure Micronesian. They are intelligent, can reason inductively, are brave, having a very respectable share of courage, and are extremely pugnacious, both sexes fighting like fiends on the least provocation. In every township there is a large house called "maneabau," in which the members of each family of "aomata" or "gentry" have a certain space allotted to them. All the social government is carried on in this house, and everything of a public nature is discussed in it. Decision is given by general vote, the majority carrying their point. The older and wealthier landowners have most influence where there are no nobles, but do not seem to have more votes than any one else. A woman can vote and speak as well as a man, and in general the women decide the question, unless it is one of war against another island.

MR. A. J. CHITTY records in the new number of the *Entomologist's Monthly Magazine* that in the neighbourhood of Forres, Morayshire, where he spent six weeks last autumn, he found that Coleoptera were very abundant. He captured specimens of a good many species new to the district, and one or two which had not, he believes, been recorded before from Scotland.

A LIST of the Batrachia in the Indian Museum, by W. L. Sclater, has been issued by the trustees of the institution. The arrangement and nomenclature are formed on Mr. Boulenger's work in the British Museum catalogues, and the Reptiles and Batrachia in the "Fauna of British India" series.

AN interesting paper on the were-wolf in Latin literature, by Kirby W. Smith, is printed in the new number of the Johns Hopkins University Circulars. The were-wolf is a person who, either from a gift inborn or from the proper use of certain magic arts of which he has learned the secret, can change himself into a wolf of unusual size and ferocity; or, furthermore, the transformation may be unavoidable, owing to the curse or charm of some outside power, and not to be got rid of until a fixed period has elapsed or various conditions, more or less difficult, have been complied with. Such enchantments are common in the folk-lore of all nations, but, on Roman ground, they do not appear in connection with the were-wolf story. Mr. Smith mentions the were-wolf story told by Petronius, who describes how the companion of the freedman Niceros took off his clothes, and, becoming a wolf, began to howl and took to the woods. Niceros tried to pick up the clothes, but found they had all turned to stone. The wolf was wounded in the neck with a spear, and afterwards Niceros found his comrade in bed, while his neck was being dressed by a doctor. Here the transformation is attributed to a power born in the person, and Mr. Smith thinks that this may be the nearest approach to the original form of the superstition, because "among savages, these modern types of early humanity, just such stories are more or less common." The other class of Roman were-wolf stories—those in which the change is effected by means of a charm—simply form one of a large number of different transformations, the theory and methods of all being practically the same.

WE have received the first part of the new *Contributions from the Botanical Laboratory of the University of Pennsylvania.* It contains papers by Dr. J. T. Rothrock on a monstrous specimen of *Rudbeckia hirta*, and on a nascent variety of *Brunella vulgaris*; by Dr. J. M. Macfarlane, contributions to the history of *Dionæa muscipula*; by Mr. J. W. Harshberger on an abnormal development of the inflorescence of Dionæa; by Mr. H. Trimble on Mangrove tannin; by Dr. W. P. Wilson on *Epigæa repens*, and on the movements of the leaves of *Melilotus alba*.

THE paper by Dr. Macfarlane on Dionæa is of great interest and confirms the statement previously made by him that, to produce closure of the leaf, two distinct stimuli are required, which may be communicated to the same hair, or to different hairs on the same half, or to hairs on opposite halves of the leaf. He regards the leaf, previous to secretion, as in a state of tetanic contraction, resulting from a series of stimuli, which may either be partially or entirely mechanical, thermal, luminous, chemical, or electric. The so-called "hairs" are not true hairs, but emergences, and their structure is described in detail. Each consists of three distinct regions, the joint, the base, and the shaft. While previous observations, such as those of Darwin and Prof. Burdon Sanderson, have been made on plants of Dionæa under abnormal conditions of cultivation, Macfarlane's are especially valuable as having been made on the plant in its native condition; and this is also the case with those of Mr. Bashford Dean, contributed to the Transactions of the New York Academy of

Sciences. Mr. Dean states that there is a marked difference in the irritability of different leaves; that the leaves usually fail in capturing the larger and more active insects; that even small insects constantly escape; and that the leaf repeatedly closes on inorganic and vegetable objects.

MR. W. SAVILLE-KENT'S book on "The Great Barrier Reef of Australia" will be ready for publication before the end of the present month. It will include a series of photographic views of coral reefs of various construction from several selected localities, with similar and also coloured illustrations and descriptions of the living corolla, coral-polyps, and other marine organisms commonly associated on the reefs. Meanwhile, Messrs. W. H. Allen and Co., who are to publish the book, have issued enlarged and very beautiful copies of some of the principal illustrations. These are intended for the use of museums, colleges, and natural history societies, and will certainly be highly appreciated wherever they may happen to be introduced.

A TRANSLATION of Prof. Weismann's "Das Keimplasma," recently reviewed in NATURE, has been issued in "The Contemporary Science Series" (Walter Scott). The translators are Prof. W. N. Parker and Harriet Rönnfeldt, who have done their work carefully. In the preface Prof. Parker explains that in the case of special technical terms which have no recognised English equivalents he has added the German words in brackets the first time they are used. He has had the great advantage of being able to consult Prof. Weismann personally with regard to many of the more difficult passages.

THE County Council of Northumberland has issued a valuable pamphlet, by Dr. W. Somerville, giving an account of experiments made last season throughout Northumberland with a view of gaining practical information regarding some points connected with the economic manuring of the turnip crop.

MESSRS. METHUEN AND CO. have added to their "University Extension Series" a volume on "The Mechanics of Daily Life," by V. P. Sells. The author makes no attempt at the mathematical treatment generally adopted, but seeks rather to use the subject "as a means of scientific training, and as an illustration of the method of examining nature by reasoning and experiment."

MESSRS. CASSELL AND CO. are publishing in monthly parts a new issue of Dr. Robert Brown's "Our Earth and its Story," with many coloured plates, maps, and upwards of 700 illustrations.

TWO important papers upon the ready preparation of large quantities of the more refractory metals by means of the electric furnace are contributed by M. Moissan to the current number of the *Comptes Rendus*. The "electric furnace" is simply a small furnace constructed of lime, so arranged that it can be intensely heated by a very powerful electric arc. A quantity of magnesia, which M. Moissan finds to be perfectly stable even at this high temperature, is first placed in the cavity of the furnace, and upon this the crucible of retort-carbon containing a mixture of powdered carbon and the metallic oxide to be reduced. When the metal is volatile a current of hydrogen is passed through the furnace, and the vaporised metal is condensed in a comparatively cool receiver. In this manner M. Moissan has succeeded in rapidly preparing considerable quantities of the metals of the alkaline earths, calcium, strontium, and barium. If the metal is not sensibly volatile it is left in the crucible after the reduction in the form of an ingot. The rare metal uranium, and the metals manganese and chromium belong to this category, and their preparation forms the subject of M. Moissan's two communications.

METALLIC uranium was prepared with great difficulty, and only in small quantities by Peligot, by reducing the oxide with an alkali metal. At ordinarily procurable temperatures the various oxides of uranium are practically irreducible by carbon. This no longer obtains, however, at the extremely high temperature of a very powerful electric-arc. The nitrate of uranium is first calcined in a porcelain crucible, whereby a reddish-coloured mixture of the sesquioxide and of the green oxide U_3O_4 is obtained. This mixed oxide is then well ground with a very slight excess of powdered carbon, and the whole tightly packed in the crucible of retort-carbon, which is afterwards placed in position in the lime furnace. Upon submitting the mixture in the crucible to the action of the arc produced by a current of 450 ampères, the reduction is completely effected in a few minutes. The ingot of uranium thus produced exhibits a brilliant fracture and great hardness. It possesses the peculiar property of sending forth a shower of incandescent sparks when struck against a piece of porcelain, or when fragments of it are shaken about in a glass flask, reminding one of the combustion of particles of freshly-reduced iron when allowed to fall through the air. The yield of the metal is very considerable; thus in one experiment of twelve minutes' duration an ingot weighing over two hundred grams was produced. The metal is not quite free from carbon, the amount of the latter depending upon the excess used. M. Moissan is now engaged in perfecting a ready mode of refining it.

IN order to prepare metallic manganese the protoxide is mixed with carbon as in the case of uranium, and the mixture submitted to the arc produced by a current of 300 ampères. The reduction is completely effected in five or six minutes, an ingot of 120 grams being readily obtained. The comparatively weaker arc derived from a current of only 100 ampères gives the same yield in 10–15 minutes. Any large excess of carbon is to be avoided as carbides of manganese are then produced. If an excess of the oxide is employed the metallic manganese obtained is almost pure, and may be preserved unchanged in open vessels. The carbides, however, are rapidly attacked by the moisture of the atmosphere, and if thrown into water evolve a gaseous mixture of hydrogen and various hydrocarbons. Chromium has always been found hitherto to be much more difficult to reduce than manganese, but complete reduction occurs in 8–10 minutes in the electric furnace, employing a mixture of the sesquioxide and carbon and a current of 350 ampères, the yield being an ingot of 100 grams. A current of only 30 ampères, however, is sufficient to produce ten grams of the metal in half an hour's time. Moreover, it is possible to refine the somewhat impure (from carbide) metal by a simple repetition of the process in presence of a fresh quantity of the sesquioxide. The pure chromium thus obtained is completely transformed into the volatile chloride when heated in a stream of chlorine. The reduction in the electric arc succeeds equally well with crude chrome iron ore, an alloy of iron and chromium being obtained from which the chromium may very readily be converted into chromate by projecting it into fused nitrate of potash or soda and subsequent extraction with water.

NOTES from the Marine Biological Station, Plymouth.—During the past week ephyræ of *Aurelia* have become quite plentiful in the Sound. The Anthomedusæ have been represented by numbers of the charming *Rathkea octopunctata* of Haeckel; and the Leptomedusæ (which are still scarce) by isolated examples of several species, including the *Thaumantias octona* of Forbes. Ctenophore ova and several larval and young Ctenophores have been noticed. The proportion of Polychæte larvæ and of Cirrhipede *Nauplii* remains fairly constant; while there has been an appreciable increase in the numbers of Brachyurous Zoœæ. The Hydroid *Sertularia argentea* and Actinian *Cereus pedunculatus* (= *Sagartia bellis*) are now breeding.

THE additions to the Zoological Society's Gardens during the past week include a Mozambique Monkey (*Cercopithecus pygerythrus*, ♂) from East Africa, presented by Mr. R. Hughes; a Bonnet Monkey (*Macacus sinicus*, ♀) from India, presented by Mr. W. Yeoman; two Herring Gulls (*Larus argentatus*) British, presented by Mr. J. S. Williams; an Ariel Toucan (*Ramphastos ariel*) from Brazil, presented by Mr. Ellis Edwards; a Great Eagle Owl (*Bubo maximus*) European, presented by Commander E. G. Rason, R.N.; two Spengler's Terrapins (*Nicoria spengleri*) from Okinawa Shima, Loo Choo Islands, presented by Mr. P. Aug. Holst; two Tuatera Lizards (*Sphenodon punctatus*) from New Zealand, presented by Capt. Worster; a Spiny-tailed Mastigure (*Uromastix acanthinurus*) from Algeria, presented by Miss Rigley; a Cuming's Octodon (*Octodon cumingi*) from Chili, deposited; an Eland (*Oreas canna*, ♂), born in the Gardens.

OUR ASTRONOMICAL COLUMN.

COMET BROOKS (NOVEMBER 19, 1892).—The following ephemeris has been computed by Ristenpart (*Astronomischen Nachrichten*, 3154) from five normal places of this comet, using the elements—

$$T = 1893, \text{ January } 6{\cdot}529304 \text{ M.T. Berlin.}$$

$$\left.\begin{aligned} \omega &= 85^\circ\ 12'\ 51''{\cdot}0 \\ \Omega &= 185\ 36\ 29{\cdot}0 \\ i &= 143\ 51\ 45{\cdot}9 \end{aligned}\right\}\ 1890{\cdot}0$$

$$\log q = 0{\cdot}0774148$$

12h. Berlin M.T.

1893.	R A. (app.) h. m. s.	Decl. (app.) ° ′	Log *r*.	Log Δ	Br.
Mar. 2	0 39 35	+22 18·6			
3	40 37	22 4·1			
4	41 37	21 50·1			
5	42 37	21 36·5	0·1738	0·3379	0·54
6	43 36	21 23·3			
7	44 34	21 10·5			
8	45 31	20 58·1			
9	0 46 27	20 46·1	0·1842	0·3563	0·47

The unit of brightness occurred on November 21·5, 1892.

COMET HOLMES (1892, III.).—M. Schulhof, in *Astronomischen Nachrichten*, No. 3153, continues the ephemeris for Comet Holmes, from which we make the following extract:—

12h. Paris Mean Time.

1893.	R.A. (app.) h. m. s.	Decl. (app.) ° ′ ″
March 2	2 30 59·8	+34 49 0
3	32 42·7	51 41
4	34 26·0	54 24
5	36 9·6	57 7
6	37 53·5	34 59 52
7	39 37·7	35 2 37
8	41 22·2	5 24
9	43 7·1	35 8 11

NOVA AURIGÆ.—Last week we mentioned that Mr. Fowler's observation of this nova consisted of two bright nebula lines situated near wave-lengths 5006 and 4956, the former being only slightly brighter than the latter. In *Astronomischen Nachrichten*, No. 3153, Mr Huggins, in a note dated February 11, writes with respect to his observations on February 7, 8, and 10, using a 4-inch Rowland grating (14,438 lines to the inch) and the second order, that the band was "resolved into a long group of lines extending through about 15 tenth-metres. The lines appeared more or less bright upon a faintly luminous background which could be traced a little beyond the lines at both ends of the group. Two lines, the brightest in the group and about equally bright, formed the termination of the group towards the blue; and a line nearly as bright as these was seen about the middle of the group. The group is therefore brighter at the blue end, but it does not possess any of the features of a fluting. No contrast in the spectroscope could well be more striking than that which this extended group of lines forms with the narrow and defined principal line in the nebula of Orion."

HYDROGEN LINE Hβ IN THE SPECTRUM OF NOVA AURIGÆ.—Owing to the curious appearance of the Hβ line in the spectrum of Nova Aurigæ, this line first appearing double and then afterwards quadruple, various explanations have been put forward to account for this peculiarity. From the hypothesis of two bodies, which did not agree with the facts observed, that of three or more bodies was suggested, until at last it was supposed that six bodies in all were in question. This supposition seemed most improbable, and since then the matter has been allowed to lie dormant. With reference to the behaviour of this line in the spectrum of vacuum tubes, Herr Victor Schumann (*Astronomy and Astrophysics* for February) has made some very interesting experiments, taking great care to use the hydrogen in as dry and pure a state as possible. We will here only refer to the most important part of the paper, leaving the reader to refer to the article itself for the apparatus, &c., employed. The photographic plates employed were made by himself according to the "silveroxydammonmethode" of Dr. Eder, of Vienna. Working with pressures from 1 to 100 mm. of mercury, the results obtained at those of 65, 80, and 100 gave the following results:—At 65 mm. Hβ and Hγ were most prominent, and in the negatives they were well defined, "although the sharpness of their edges is injuriously affected by broad, hazy fringes of considerable intensity, which shade off into the background from both sides of the line." Under a pressure of 80 mm. Hβ lost most of its definition, and close to it on each side were observed two fine thin lines, the fringe also being present but a little wider than before. Hγ, although increased in breadth, has lost its definition. With a pressure of 100 mm., "the more refrangible component of the pair of lines just mentioned as belonging to Hβ, has disappeared, and in its place has appeared Hβ itself, broad, but very weak; near by on the lower side one observes a thin line twice." With reference to the fringe of Hβ he says, it has now "spread itself out more towards the blue than the red, thus displacing the middle of it towards the blue." Hγ remains a very weak line. These observations showed that of all the hydrogen lines Hγ was the only one that showed reversal as well as displacement, and he concludes with the remark that "if it be asked whether the phenomena of reversal as observed in my hydrogen spectra furnish in themselves an explanation of the reversal of the lines in the spectra of Nova Aurigæ, the answer must be decidedly in the negative."

COINCIDENCE OF SOLAR AND TERRESTRIAL PHENOMENA.—Since Prof. G. E. Hale commenced his solar researches at the Kenwood Observatory, much has been added by him to our knowledge of the physics of the sun. Faculæ, for instance, which were supposed to be scattered only here and there on the solar surface, are now found, by means of the fine spectroheliograph, to occupy largely both hemispheres, and sometimes to extend in almost unbroken belts across the disc. This fact has led him to consider the question of the probability of chance coincidence between terrestrial magnetism and spots and faculæ (*Astronomy and Astrophysics*, for February), his attention being especially brought in this direction through a paper communicated to the Paris Academy of Sciences by M. Marchaud. M. Marchaud, in summing up his results after an examination of both solar and magnetic observations, says, with reference to the curve of magnetic intensity, that "each of these maxima sensibly coincides with the passage of a group of spots or a group of faculæ at its shortest distance from the centre of the disc." From an examination of 142 photographs of the sun, obtained between January 25 and December 3, 1892, at the Kenwood Observatory, Prof. Hale finds that no less than 132 show "one or more groups of faculæ on the central meridian, *i.e.* at their shortest distances from the centre of the solar disc." The chances, therefore, that at any given time one or more groups may be located at the central meridian, he finds as 0·93. This value, as he remarks, will be reduced for periods of decreased solar activity, but "coincidences noted in epochs like the present can hardly be regarded as of great importance."

"ASTRONOMICAL JOURNAL" PRIZES.—In addition to the prizes already offered, and to which we have previously referred (NATURE, vol. xlvii., Astronomical Column, p. 282), two extra ones, subject to the same conditions, are now to be presented. The first is to be given to "the observer making, by Argelander's method, the best series of determinations of maxima and minima of variable stars during the two years ending 1895, March 31." The sum in this case is two hundred dollars. It is stated that "a principal basis for the award is to be the extent to which the determinations will contribute to our better knowledge of the periodic variables by furnishing the largest number of maxima or minima of the largest number of stars, having especial regard to stars whose characteristics are at present not very well known." The award of four hundred dollars will be given for the "most thorough discussion of the rotation of the earth, with reference to the recently discovered variations of latitude." The manuscript (which will be returned to the author) is to be transmitted to some one of the judges not later than March 31, 1895.

For the award of these prizes the judges are Messrs. Asaph Hall, Seth C. Chandler, and Lewis Boss.

GEOGRAPHICAL NOTES.

THE Liverpool Geographical Society has issued its first annual report, which, although not showing a very cordial reception of the new society by the public, is not without some promise of future growth. The Earl of Derby is President, there are twenty-two Vice-Presidents, a substantial Council, and a staff of honorary officials. Staff-Commander E. C. Dubois Phillips has been appointed Secretary. The second year of the society was inaugurated by a lecture on the Discovery of the Alps, by Mr. D. W. Freshfield, President of the Alpine Club, and one of the Secretaries of the Royal Geographical Society. Other lectures have been arranged for, and it is to be hoped that the membership of the society will rapidly increase.

THE tenth German Geographentag is announced to meet in Stuttgart on April 5, 6, and 7. The programme includes (1) The special geography of Würtemberg and the researches on the lake of Constance; (2) Recent geographical investigations with special reference to desert phenomena; (3) Cartography; (4) Economic or applied geography; and (5) School geography. An exhibition will be held at the same time, mainly of objects illustrative of the geography of Würtemberg.

PROF. PENCK has a long paper in the March number of the *Geographical Journal*, describing in detail his scheme for a map of the world on the scale of 1 : 1,000,000. The importance of having maps of every country on one scale has long been recognised by working geographers; but, with the exception of the little atlas on gnomonic projection by the late R. A. Proctor, we do not know of any effort having been made to place such maps before the public. The minute scale of the work referred to reduced its value to a minimum. Prof. Penck's scheme is one of great magnitude. He would allocate the production of the map to the Governments or public bodies of each country. On this principle, 769 sheets would be required to represent the land-surface of the globe, each sheet containing 5° square between the equator and 60°, and between 60° and the poles 5° of latitude and 10° degrees of longitude. The British Empire would be responsible for 222 sheets, Russia for 192, United States for 65, France 55, Scandinavia 54, China 45. Five countries would have from 20 to 30 sheets each, six more would have over 10, and ten countries would require a smaller number, Belgium, Switzerland, and Greece having only one each. One advantage of the proposed scale is that it corresponds within the limits of the shrinkage of paper with the 16 miles to an inch Survey of India maps (1 : 1013760) and with the 25 versts to an inch Russian maps (1 : 1050000).

MONGOLIA AND CENTRAL TIBET.

AT the meeting of the Royal Geographical Society on Monday Mr. W. Woodville Rockhill gave an interesting account of a journey in Mongolia and Central Tibet. Leaving Peking on December 1, 1891, Mr. Rockhill travelled to the frontier town of Kalgan, then, entering Mongolia, he passed through the pasture-lands of the Ch'ahar Mongols. After a few days spent at Kuei-hua Ch'eng, the traveller continued westward, and crossing the Yellow River on the ice at Ho-k'on, he crossed the Ordos Mongols country, and afterwards Alashan. Again entering China proper the route led through Ning-hsia, Lanchou, and Hsi-ning, the westernmost town in China, on the high road to Tibet. On March 14 Mr. Rockhill left for Tibet by an unexplored route, passing south of the Koko nor and along the foot of the mountains to the south side of the Ts'aidam, making several excursions on the way, one of special importance from the Mongol village of Shang to Tosu Nor to determine by astronomical observations the position of this sheet of water discovered by him in 1889. Mr. Rockhill's party consisted originally of five Chinese, but one had to be invalided home a few days after leaving Kumbum, and two others deserted him at Shang. He was able to hire at this place an old Chinese trader, and with these three men, assisted for a while by a Mongol and then by a Tibetan guide, he travelled till he reached China again in October, 1892. On May 27 the final start for Tibet was made from the Naichi gol in western Ts'aidam, and a general south-westerly direction was followed until July 7, when a point some 30 miles from the north-west corner of the great central Tibetan lake, called Tengri nor by the Mongols, was reached. Between the Naichi gol and the Ts'aidam the party had to endure great hardships, the great altitude ranging from 14,000 to 17,000 feet above sea-level, terrible daily snow and hail-storms, fierce winds and frequent absence of fuel, and towards the end starvation. The route, moreover, led them through vast salt marshes, bogs, and across numerous rivers, in which quicksands were frequently found. The geographical results of this portion of the journey were important. (1) The determination of the limits of the basin of the Murus (the great Yang-Tzŭ Kiang of China) and the discovery of the sources of the main branch of this river in the snow-covered flanks of the great central Tibetan range of mountains known as the Dangla. (2) The discovery of the eastern limit of the lake-covered Central Asian plateau which becomes some 600 miles west of the route Mr. Rockhill followed the Pamir, but is in the section he crossed of it called Naktsang, and sometimes, though apparently erroneously, Chang T'ang or "Northern Steppe."

Game was scarce in the great part of this region, and so wild that it could not be approached.

On July 2 the last provisions were eaten, and from that date to the 7th the party subsisted solely on tea. On the latter day a small encampment of Tibetans was reached, and a little food purchased. The next day a valley was entered dotted over with tents; it was the pasture lands of the Namru Tibetans and Lh'asa governed territory. The headman refused to give the party food unless Mr. Rockhlll agreed to await the arrival of the head chief, who would decide as to whether he should be allowed to proceed southward, or be sent back to the north.

After six days' discussion with the chief and several officials from Lh'asa a compromise was effected; and Mr. Rockhill, with an escort of ten Tibetan soldiers, started eastward to reach the frontier port of Nagchuká, on the highroad to Lh'asa from the Koko nor.

On July 27 Mr. Rockhill crossed the Dangch'u and found himself on the territory of Jyadé, or "The Chinese Province," which is governed by native chiefs appointed by the Chinese Minister, resident at Lh'asa (or Lh'asa Amban). This important province was separated from Lh'asa by the Chinese in the seventeenth century, in view of the enmity existing between its people, who profess the Bonbo religion, a form of the devil worship or shamanism, though now mixed up with lamaism to such an extent, that it is hardly distinguishable from it, and the followers of the yellow and red sects of Buddhism living on Lh'asa soil.

Passing to the south of the city of Ch'amdo, to which town Mr. Rockhill, like his predecessor, Captain Bower, was refused admittance, the high road to China was reached at Pungdé (two stages south of Ch'amdo), and from this point to China a Chinese escort was given the traveller, and he was able to enjoy (!) all the luxuries of Chinese travel. Stopping at Draya, at Gartok, Bat'ang and Lit'ang, Ta-chien-lu, in Ssŭ-ch'uan, was reached on October 2. Here, on the eastern border of Tibet the journey was practically ended, for, though several thousand miles still separated Mr. Rockhill from the seaboard, they could be travelled in comfort and rapidity. Leaving Ta-chien-lu on October 5, he was in Shangai on the 29th, exactly eleven months from the time he had left it. "In that time I had travelled about 8000 miles, surveyed 3417, and during the geographically important part of the journey crossed sixty-nine passes, all of them rising over 14,000 feet above sea-level, and not a few reached 18,000. I had taken series of sextant observations at a hundred points along the road, determined one hundred and forty-six altitudes by the boiling point of water, taken three hundred photographs, and made important ethnological and botanical collections. For two months we had lived at an altitude of over 15,000 feet, soaked by the rains and blinded by the snow and hail, with little or nothing to eat, and nothing to drink but tea, and yet not one of us had a moment's illness from the day we left till we reached our homes again."

GASES IN LIVING PLANTS.[1]

PLANTS are permeated by the same gases that make up the atmosphere surrounding them: oxygen, carbon dioxide and nitrogen. Nitrogen in the form of a gas is neither used nor generated by any part of plants, unless we except the tubercles of certain roots, and so it occurs in about the same percentage inside the plant as outside of it. On the other hand, both oxygen and carbon dioxide enter into combination with, and are liberated from, the plant tissues in varying amounts at different times. The percentage of these two gases in the cavities of the plant vary through a considerable range. In a series of determinations made by Lawes, Gilbert, and Pugh, in England, the oxygen ranged from 3 to 10 per cent., and the carbon dioxide from 14 to 21 per cent. in plants which had been for some time in the dark, while plants which had been standing in sunlight reversed these figures, and gave 24 to 27 per cent. of oxygen and 3 to 6 per cent. of carbon dioxide. The two gases, therefore, bear a somewhat reciprocal relation, their sum usually being about 25 to 30 per cent. of the total gas in the plant.

The variations in the relative amount of oxygen and carbon dioxide are due to two independent processes incident to the life of plants. One of these processes is assimilation, by which all green cells of plants in the presence of sunlight, or its equivalent, such as a strong electric light, absorb carbon dioxide and liberate oxygen. This process goes on with great rapidity in healthy cells, but is entirely checked upon the withdrawal of light, or when it reaches a certain low intensity. Of course it never takes place in roots, flowers, the central portion of large stems, or other parts which are not green, nor in any fungi or other plants not possessed of green colouring matter.

The other great cause of disturbance in the relation of oxygen and carbon dioxide in the plant is the process of respiration.

Respiration in plants is essentially the same as in animals, and consists in a fixation of oxygen and the liberation of carbon dioxide. It takes place in every living cell, whatever the kind of plant, whatever the part of the plant, and whatever the conditions of active existence. The rate of respiration varies with the temperature, the age of the cell, and the nature of the chemical transformations. In normal respiration the amount of oxygen absorbed is approximately the same as the amount of carbon dioxide evolved. There are, however, certain modified forms of respiration in which this does not hold true.

If living plants be placed in a vacuum, or in an atmosphere deprived of oxygen, it is found that they can still carry on life processes for some time, accompanied with an evolution of carbon dioxide. The oxygen necessary for this process is obtained from the breaking up of compounds in the cells, and it is therefore called intramolecular breathing.

The germination of seeds, which contain a large amount of oil, is somewhat the opposite of this last process. In order to convert the fat into a more directly serviceable food material for the plant, a large amount of oxygen enters into the new combination, for which there is no equivalent amount of gas liberated. It consequently comes about that oily seeds in germinating absorb a far larger amount of oxygen than they liberate of carbon dioxide. This is known as vincular breathing.

Another variation from normal respiration is known as insolar breathing, and which, with still some other modifications, I need not stop to explain. To this brief statement of plant respiration must be added that much yet remains to be discovered regarding the details of the processes.

Assimilation and respiration are the two great causes which disturb the relative volume of the two variable gases in plants.

We shall now turn to the movement of the same two gases, oxygen and carbon dioxide. There has never been a disposition as in the case of many other plant phenomena, to explain the movement of gases upon any other than purely physical principles. We have therefore to do simply with the question of the aids and hindrances to the establishment of an equilibrium between the gases inside and outside the plant, irrespective of whether the cells are alive or dead.

It has already been stated that the relative amounts of oxygen and carbon dioxide inside the plant are usually very different, and that within a few hours the relation of the two may be completely reversed. To this may be added that the pressure of the gases inside the plant is sometimes more, sometimes less than that of the atmosphere outside the plant, almost never the same. Hales observed in his early work that a mercury gauge connected with the inside of the trunk of a tree showed an internal pressure when the hot rays of the sun warmed the trunk. This was largely due, undoubtedly, to an expansion of the gases in the trunk, by the heat. Such an excess of pressure in water plants is very common, although due to other causes. It may readily be shown by breaking stems under water, when bubbles of gas will be liberated, as undoubtedly many have noticed in gathering water lilies, or other water plants.

On the other hand, the pressure of the gas inside the plant may be less than on the outside. This has long been recognised, but was best demonstrated by Von Höhnel in 1879, to whom it occurred to cut off stems under mercury. In doing so the mercury rose to a considerable height in the vessels of the stem, and as mercury is without capillarity, this can only be ascribed to the greater pressure of the outside air, or in other words, to a partial vacuum in the plant.

An observation was made by Hales, which we may use to illustrate how such a negative pressure, as it has been called, can be brought about. He cut off a branch, fastened an empty tube to the cut end, and plunged the other end of the tube into a liquid. He found that as evaporation of moisture from the leaves took place, the liquid was drawn up into the empty tube. This phenomenon can now be explained more satisfactorily than could be done at that early day. By evaporation the liquid water inside the plant escapes in the form of vapour, and the space it occupied is filled by the gases, thus rarifying them. This rarifaction may go on in uninjured plants until the internal pressure is greatly reduced. But in the experiment, the pressure is equalised by the rise of the liquid in the tube. A later modification of Hales' experiment is to use a forked branch, place the cut end in water to give a continuous supply of moisture for transpiration, and attach the empty tube to one of the side forks of the stem, cut away for that purpose.

It is self-evident that such condensation and rarifaction of the gases in the plant could not take place if the cell walls were readily permeable to gases. Thus it comes about that one of the most important topics in connection with the movement of gases in the plant, is the permeability of tissue walls of various kinds, and especially those constituting the surface covering of plants.

I shall not attempt to conduct you through the tangle of supposition and fact, errors in experiments, correct and incorrect conclusions, and the general confusion which has come from the labours of physicists, chemists and botanists for the last twenty-five years, during which the subject has received particular attention. The results of the later work have been to cast grave doubts upon the correctness, or at least the interpretation of some of the experiments most relied upon heretofore. Nevertheless many points still lie open for verification, and untouched parts of the subject await investigation.

In the earlier days it was found that the leaves and young stems of plants have their epidermis more or less well supplied with minute openings, called stomata, or breathing pores, which communicate with small air cavities inside, which in turn branch out among the cells into a network of minute passages rarifying throughout the plant. This intricate network of intercellular passages affords an air communication throughout the whole plant, and connects directly with the outside atmosphere through the stomata. Subsequent to the discovery of stomata, it was ascertained, that in stems more than one year old, the stomata are replaced by another kind of opening, known as lenticels, which in some form are doubtless to be found in the bark of shrubs and trees of whatever age.

Gases stream into and out of the plant through the stomata and simpler lenticels, according to the law governing the movement of gases through minute openings in thin plates. The rate of movement is accordingly proportional to the square roots of the density of the mixing gases. Such a movement of gases is known as effusion.

The movement by which gases pass from one part of the

[1] Reprinted from the *American Naturalist* for February.

plant to another, through the intercellular spaces, is governed by other laws. It was at first thought that the rate of movement would correspond to that in capillary tubes, according to the well-known law of Poisenille, that it is proportional to the fourth power of the diameter, divided by the length of the tube. But upon testing the matter two years ago, Wiesner found that owing to the extreme minuteness of the intercellular spaces, and their zigzagged and branched condition, this law does not hold, neither does the movement prove to be proportional to the density of the gases. The discovery of the law of the rate of movement of gases in intercellular spaces, that is, the transpiration of gases, is, therefore, yet to be discovered, together with other interesting facts pertaining to the subject. Poisenille's law does, however, hold good for the movement of gases in the woody ducts, but here it is of limited application, for these do not connect with one another, with the intercellular spaces, or with the exterior of the plant.

The walls of most cells, ducts, and surface covering of plants, except as already mentioned, are imperforate, that is without any openings that can be demonstrated by the microscope. If gases pass through them, it must be in accordance with some law of diffusion, or osmosis. Many experiments in this line have been tried, and the results have been of the most diverse character. It is impossible to give a fair idea of the subject in the time at my disposal, and it must suffice to mention a few bare facts.

The most astonishing and important results were obtained by Wiesner, in experiments conducted at Vienna, two years since. It would be a most natural interpretation, it seems to me, to think that the gases are forced from one cell to another, through the cell walls by differences in pressure. Wiesner found, however, that it is impossible to force gases through cell walls of any kind whatever, by any pressure they will stand, acting for any length of time. For instance, a bit of grape skin held up a column of mercury, 70 centimetres high, for seventy-five days, and a piece of cherry skin withstood a pressure of 3 atmospheres for twenty-four hours. Similar experiments were tried with cuticularised, suberised, liquefied and simple cellulose tissues from many sources, and with uniformly the same results, whether the tissues were moist or dry, alive or dead.

But in the same set of experiments it was found that if gases cannot be forced through cell walls, they will readily pass through by simple osmotic diffusion. All cells permit the passage of gases by diffusion when moist, dependent upon the coefficient of absorption and the density of the gas. Cuticular and corky formations also permit the passage of gases when dry. Thus we see that gases may be forced through the stomata, or breathing pores, by varying pressure, but can only pass through the epidermis and bark of plants by diffusion. We therefore arrive at the conclusion that the gases inside and outside of the plant are brought to an equilibrium by direct interchange through the stomata and intercellular spaces, aided by the comparatively slow process of diffusion through the whole surface of the plant, both above and below ground.

J. C. ARTHUR.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

OXFORD.—The Curators of the Hope Collections will proceed to the election of a Hope Professor in Trinity Term 1893. Candidates for the Professorship, of which the emoluments are £480 per annum, are required to send in their applications, together with such evidence of their qualifications as they may wish to submit to the Curators, on or before May 1, 1893, to the Registrar of the University, Clarendon Buildings, Oxford. The duties of the Hope Professor are, to give public lectures and private instruction on zoology with special reference to the Articulata, to arrange and superintend the Hope collection of annulose animals, and to reside in the University for the term of eight months in every academical year between October 1 and July 15.

Physiological Department.—It is satisfactory to note that the number of students in this department is greater than in any previous corresponding term. The increase is due not only to the larger number of candidates for the M.B. degree, but also to a larger number of candidates for honours in Physiology in the Honour School of Natural Science. The course of study during the term has comprised lectures on the general subjects of the Honour School by the Waynflete Professor on the physiology of nutrition, by Dr. J. S. Haldane; and on the nervous System, by Dr. E. Starling. Mr. Leonard Hill has undertaken the course of lectures on elementary physiology. Practical instruction has been carried on under the superintendence of Dr. Haldane and Mr. M. S. Pembrey.

SCIENTIFIC SERIALS.

Bulletin of the New York Mathematical Society, Vol. ii. No. 4 (New York, 1893).—The contents of this number are an abstract of a paper (read before the Society, June 4, 1892) by Prof. W. Woolsey Johnson, entitled "On Peters's Formula for Probable Error" (pp. 57-61). A clear abstract of Engel and Sophus Lie's Theorie der Transformationsgruppen, by C. H. Chapman (pp. 61-71), and a similar account of U. Dini's work on the theory of functions of a real variable, by J. Harkness (pp. 71-76). Notes and new publications complete the number.

Bulletin de l'Académie Royale de Belgique, No. 12.—An unpublished corollary of Kepler's laws, by F. Folie. A deduction of Dewar's empirical formula for the ratios of the mean velocities of the planets from Kepler's third law.—On the common cause of surface tension and evaporation of liquids (preliminary note) by G. Van der Mensbrugghe. The author endeavoured to show in 1886 that the particles of a liquid are at distances apart which increase as we approach the surface, and that therefore the tension is greatest at the surface. Following up this view, he regards surface tension as the elastic force due to tangential displacement of surface particles, and evaporation as produced by molecular displacement beyond a certain limit in a direction normal to the surface. He predicts that a liquid of high surface tension will be able to evaporate across another liquid which has a lower density and surface tension, and does not mix with the former.—On a new optical illusion, by M. J. Delbœuf.—On the reduction of invariant functions in the system of geometric variables, by Jacques Deruyts.—Construction of a complex system of straight lines of the second order and the second class, by François Deruyts.—Contribution to the study of diastase, by Jules Vuylsteke.—Pupine, a new animal substance, by A. B. Griffiths.—Two experimental verifications relative to refraction in crystals, by J. Verschaffelt. Billet has calculated that if refraction takes place on a cleavage face of a crystal of Iceland spar, the angle of refraction for the extraordinary ray corresponding to normal incidence is 6°12′, and that the ray is normal with an incidence of 9° 49′. M. Verschaffelt has determined these angles experimentally, and found them to be 6° 9′ and 9° 45′ respectively, thus showing a close agreement with the theoretical values.—On the bacterian fermentation of sardines, by M. A. B. Griffiths.—On prejudices in astronomy, by M. F. Folie.—On the constitution of matter and modern physics, by P. de Heen.

Ann. dell' Ufficio Cent. Meteor e Geodinamico, ser. secund., part iii. vol. xi. 1889. Roma, 1892.—Fumo di Vulcano veduto dall' Osservatorio di Palermo durante l'eruzione del 1889, by A. Ricco.—From the obervatory terrace (72m. above sea level) the summits of some of the Lipari islands are visible, but that of Vulcano (140km. distant) is not so. Any smoke or vapour that exceeds 300m. in height can, however, be seen. The author was not successful in either photographing or measuring the dimensions of the smoke cloud, which were, however, estimated by comparison with the size of Alicuri, which had been carefully determined. At the commencement of the observations (January 6, 1889) the smoke column reached a height 10½km. and had the form of the pine tree. Several drawings are given, and the form assumed in some cases is very curious. The paper terminates with some thermodynamical calculations, which are very interesting, but unfortunately based on false premises. The author supposes that the eruption was caused by the access of the sea-water. He supposes this to be at sea level, and calculating the pressure at this point, concludes the vapour was produced from water heated to 196° C. only. He seems to be unacquainted with the solution of H_2O in the fluid volcanic glass, the vesiculation and escape of vapour from it, involving so many data with which the physicist has not yet supplied us, as to make any calculations of such a nature of a highly romantic rather than of practical use.

Mem. Soc. degli Spettroscopisti Ital. vol. xxi. 1892.—La Grandissima Macchia Solare del Febbrajo 1892, by A. Ricco.—This memoir is a description of an enormous sun-spot which developed from some small ones that had been noticed during three rotations before January 17. On February 5, they made their grand entry on the solar face on the east side, and by the 7th could be seen by the eye aided only by a smoked glass. The whole spot was composed of a very large one surrounded by smaller ones, and composed of great tongues of flame extending in towards the nucleus, sometimes arranged in a spiral manner. It attained its maximum on February 11, when the whole patch measured, in earth diameters, as follows: Total length, 20; total breadth, 8; the more compact extended 8 in each direction. After this the breaking up of the spot proceeded at a rapid rate, and by rotation the spot passed out of sight on the 18th. On the next rotation the diminution was much more marked. The author gives six observations of latitude, eight drawings, and several spectroscopic observations on the flames.

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, February 23.—"On the Mimetic Forms of certain Butterflies of the Genus *Hypolimnas*." By Colonel C. Swinhoe, M.A. Communicated by Prof. E. Ray Lankester, F.R.S.

The object of this investigation is to study the changes undergone by the species of a small group of butterflies as they are traced from one locality to another, and to ascertain the bearing of these facts upon the theory of mimicry.

We find the representatives of the Indian *Hypolimnas bolina* in a long list of localities in Malaya, Polynesia, and Africa: the local representatives differ from each other and from the Indian form, but they agree in possessing in one or both sexes a more or less superficial resemblance to some conspicuous species belonging to a specially defended group and inhabiting the same locality; the same is true of the three forms of the female of *Hypolimnas misippus*.

The facts afford the most convincing evidence of the truth of the theory of mimicry enunciated by H. W. Bates.

The study of these numerous but closely-related forms belonging to the genus *Hypolimnas* also throws light upon such interesting questions as:—

(1) The special liability of the female to become mimetic.

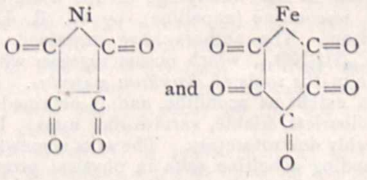
(2) The ancestral form from which the various mimetic varieties have been derived.

(3) The mimetic resemblance to different species in the same locality.

(4) The divergent conditions under which mimicry appears in closely-related species.

(5) The relation between selection and variation in the production of mimetic resemblance.

Physical Society, February 10.—Annual general meeting.—Mr. Walter Baily, Vice-President, in the chair.—The reports of the Council and Treasurer were read and approved, copies of the balance-sheet being distributed to members. From the former it appears that the society now numbers 371 ordinary members and 12 honorary members, and during the past year the society has lost six members by death, viz. the Rev. T. Pelham Dale, Dr. J. T. Hurst, B. Loewy, C. E. Walduck, G. M. Whipple, and P. W. Willans. Obituary notices accompany the report.—The treasurer's statement shows the financial condition of the society to be satisfactory. A cordial vote of thanks to the Committee of Council on Education for the use of the rooms and apparatus of the Royal College of Science was proposed by Mr. Shelford Bidwell, seconded by Mr. Blakesley, and carried unanimously. A similar vote was accorded to the auditors, Mr. H. M. Elder and Mr. A. P. Trotter, on the motion of Dr. Gladstone, seconded by Prof. S. P. Thompson. Prof. Ramsay proposed a vote of thanks to the officers of the society for their services during the past year; this was seconded by Prof. Fuller, and carried. Prof. Perry responded. The following gentlemen were declared duly elected to form the new council:—President: Prof. A. W. Rücker, F.R.S. Vice-Presidents: Walter Baily, Major-General E. R. Festing, F.R.S.; Prof. J. Perry, F.R.S.; Prof. S. P. Thompson, F.R.S. Secretaries: H. M. Elder, 50, City Road, E.C.; and T. H. Blakesley, 3, Eliot Hill, Lewisham, S.E. Treasurer: Dr. E. Atkinson, Portesbery Hill, Camberley, Surrey. Demonstrator: C. Vernon Boys, F.R.S., Physical Laboratory, South Kensington. Other members of Council: Shelford Bidwell, F.R.S., W. E. Sumpner, Prof. G. Fuller, J. Swinburne, Prof. J. V. Jones, Rev. F. J. Smith, Prof. G. M. Minchin, L. Fletcher, F.R.S., Prof. O. Henrici, F.R.S., James Wimshurst.—In response to invitations for suggestions regarding the working of the society, Prof. S. P. Thompson said all must appreciate the efforts of the late Council, and particularly of the honorary secretaries, in making the society better known. But he could not help thinking that there were many persons amongst teachers of physics and scientific amateurs whose active sympathies it was desirable to engage, who were not yet associated with the society. Perhaps the time of meeting was not convenient for all, but he thought much might be done by freely circulating particulars of what was going on at the meetings. The daily papers merely announced the meetings, but said nothing as to the place of meeting or the papers to be read. In his opinion the society did not take the position in the scientific world to which it was entitled, and he wished to inspire members with a determination to bring its claims prominently forward.—Mr. Blakesley pointed out that almost all the scientific and technical papers gave full announcements of the meetings and of the papers to be read.—Mr. W F. Stanley said Friday afternoon was not convenient for scientific men engaged in trade.—The meeting was then resolved into an ordinary science meeting.—Dr. J. H. Gladstone, F.R.S., read a paper on some recent determinations of molecular refraction and dispersion. The paper relates to the new metallic carbonyls, the metals indium and gallium, sulphur, and to liquefied oxygen, nitrous oxide, and ethylene. The carbonyls were found to be extremely refractive and enormously dispersive. For iron pentacarbonyl, $Fe(CO)_5$, the molecular refraction for the line α of hydrogen was found to be about 68·5, and the molecular dispersion between γ and α of hydrogen 6·6. For nickel tetra-carbonyl, $Ni(CO)_4$, the corresponding numbers are 57·7 and 5·93. In discussing the results it was pointed out that if the molecular refraction of CO be taken as 8·4, the value expected in organic substances, then the atomic dispersions of nickel and iron come out greatly in excess of the known values as determined from solutions of their salts. The author considers the most probable explanation of the excessive refractions and dispersions of the carbonyls is to be sought in the peculiar arrangement of the CO, and on optical as well as chemical grounds accepts the ring formulæ indicated by Mr. Mond in his lecture at the Royal Institution, viz.:—



On this supposition the molecular refraction of CO comes out 11·9 from the nickel compound and 11·3 from the iron ore, whilst the molecular dispersion (γ—α) is about 1·3 in each case. For indium and gallium the atomic refractions calculated from latest data are 13·7 and 11·6 respectively. Sulphur has been examined in the states of solid, liquid, and gas, and also in simple chemical combination and in solution, all the resulting numbers for its atomic refraction being remarkably concordant. For the line C this is about 16. The dispersions in all the different states are also in close agreement. Numbers relating to carbon and chlorine are also given. The specific refractions of oxygen, nitrous oxygen, and ethylene in the liquid states had been recently determined by Profs. Liveing and Dewar. For liquid oxygen the refraction equivalent (3·182) differs little from that deduced from gaseous oxygen at ordinary temperatures (3·0316), and also corresponds fairly closely to the 3·0 obtained by Landolt from organic compounds. Liquid nitrous oxide gave 11·418 and 11·840 as the molecular refractions for the red ray of lithium and the line G respectively. In discussing these numbers it was pointed out that nitrogen in nitrous oxide was not in the same condition as nitrogen in ammonia. The latest determinations with liquid ethylene gave the molecular refraction for the line A as 17·41, the theoretical value being 17·40, thus showing very close agreement.—Mr. E. C. C. Baly made a communication on separation and striation of rarefied gases under the influence of the electric discharge.

Chemical Society, February 3.—Dr. W. H. Perkin, Vice-President, in the chair. The following papers were read:—The connection between the atomic weight of the contained metals and the magnitude of the angles of crystals of isomorphous series, by A. E. Tutton. The author has made a detailed goniometrical investigation of twenty-two salts belonging to the $R_2M(SO_4)_2,6H_2O$ series of double sulphates containing as the alkali metal R potassium, rubidium or cæsium, and as the dyad metal M magnesium, zinc, iron, manganese, nickel, cobalt, copper, or cadmium. On classifying the salts into three groups according to the alkali metals which they contain, it is found that the geometrical and other properties of the salts containing rubidium as the monad metal, lie between those of the corresponding potassium and cæsium salts. Thus the cæsium salts show the greatest power of crystallising, those of potassium the least, whilst the salt containing rubidium occupy an intermediate position in this respect. Similar behaviour is observed with regard to the crystalline habits of the various salts; each of the three groups is characterised by the possession of a distinctive habit. The crystalline habit of the salts containing potassium is widely different from that of the salts containing cæsium; the specific characteristic habit of the rubidium salts is of an intermediate nature. There is a difference of some two degrees or so between the axial angles (β) of the potassium and cæsium salt crystals containing the same dyad metal; the magnitude of the angle β in the corresponding rubidium salt is approximately the mean of these two. The differences between the axial angles are hence approximately proportional to the differences between the atomic weights of the contained alkali metals if the dyad metal remain the same. The magnitudes of all the angles between the faces of the crystals of the salts of this series containing rubidium as the alkali metal lie between, though not ordinarily midway between, the magnitudes of the corresponding angles upon the crystals of the potassium and cæsium salts containing the same dyad metal. The alkali metals exert a preponderating influence upon the geometrical form of the crystals, the magnitudes of the angles being altered on displacing one alkali metal R by the next higher or lower to an extent attaining a maximum, in certain angles, of more than a degree, whilst the displacement of the dyad metal M by any other of the same group is unattended by any material change in the angular magnitudes.—The preparation of phosphoric oxide free from the lower oxide, by W. A. Shenstone and C. R. Beck. Phosphoric oxide may be freed from the lower oxides by distilling it over platinum sponge in presence of excess of oxygen.—Contributions to our knowledge of the aconite alkaloids: Part iv., on isaconitine (napelline), by W. R. Dunstan and E. F. Harrison. The authors have examined the alkaloid isaconitine $C_{33}H_{45}NO_{12}$, which occurs together with its isomeride aconitine in the roots of *Aconitum napellus*. It is present to as great an extent as aconitine, and is obtained in the pure state as a colourless, friable, varnish-like mass. Its alcoholic solution is feebly dextrorotatory. The salts somewhat resemble the corresponding aconitine salts in physical properties. On attempting to prepare an aurichloride, aurochlorisaconitine, $C_{33}H_{44}(AuCl_2)NO_{12}$, results. Isaconitine is gradually hydrolysed by mineral acids or water yielding the same products as does aconitine, viz. aconine and benzoic acid

$$C_{33}H_{45}NO_{12} + H_2O = C_{26}H_{41}NO_{11} + C_7H_6O_2.$$

Whilst aconitine is a most violent poison, even in excessively minute doses, relatively large quantities of isaconitine must be administered to small animals in order to produce a toxic effect, which effect is the result of a physiological action in the main distinct from that of aconitine. It seems doubtful whether isaconitine would prove toxic to man, except when given in very large doses.—Contributions to our knowledge of the aconite alkaloids: Part v., the composition of some commercial specimens of aconitine, by W. R. Dunstan and F. H. Carr. The great differences in toxic power exhibited by different samples of aconitine have led the authors to examine sixteen specimens of "aconitine from *A. napellus*." Most of the samples were amorphous; these contained little or no aconitine, but were chiefly composed of aconine, isaconitine, and homoisaconitine, all of which appear to be very slightly, if at all, toxic. Of the crystalline specimens examined, only two were pure, most of them being contaminated with more or less amorphous alkaloid. Hence it is not surprising that great differences have been observed in the mode of action and toxic power of commercial "aconitine."—Synthesis of oxazoles from benzoin and nitriles, by F. R. Japp and T. S. Murray. The authors find that nitriles and benzoin interact with elimination of water when a mixture of the two compounds is dissolved in concentrated sulphuric acid, an oxazole being formed in which the hydrocarbon radicle attached to the cyanogen of the nitrile occupies the *meso*-position. Thus acetonitrile yields in this manner $\alpha\beta$-diphenyl-μ-methyloxazole

$$\begin{array}{l}\text{Ph.CH.OH}\\ \quad | \\ \text{Ph.CO}\end{array} + \text{NC.Me} = \begin{array}{l}\text{Ph.C.O}\\ \quad \| \\ \text{Ph.C.N}\end{array}\!\!\!>\text{C.Me} + H_2O.$$

A number of instances of this reaction are cited. The above oxazole, when treated with ammonia, is converted into the corresponding imidazole identical with Japp and Wynne's methyldiphenylglyoxaline.—The action of nitrosyl chloride and of nitric peroxide on some members of the olefine series, by W. A. Tilden and J. J. Sudborough. Ethylene dichloride alone results from the interaction of ethylene and nitrosyl chloride. Propylene and butylene yield with nitrosyl chloride a mixture of dichloride and nitrosochloride, whilst trimethylene (amylene) is almost entirely converted into nitrosochloride.—Piperazine, by W. Majert and A. Schmidt. The authors correct certain erroneous statements regarding the physical and chemical characters of piperazine. They have prepared the following series of hydrates of piperazine, the hexhydrate, which crystallises from dilute aqueous solutions, being the most readily formed:—

$C_4H_{10}N_2$, H_2O	m. p.	75°
,, , $2H_2O$	,, ,,	56°
,, , $3H_2O$	,, ,,	39-40°
,, , $4H_2O$	,, ,,	42 43°
,, , $5H_2O$	,, ,,	45°
,, , $6H_2O$	,, ,,	48°

Linnean Society, February 16.—Prof. Stewart, President, in the chair.—Mr. Clement Reid exhibited and gave an account of some seeds of *Paradoxocarpus carinatus*, an extinct Pliocene and Pleistocene plant from the Cromer fossil bed. Mr. Reid also exhibited and described some examples of *Potamogeton headonensis*, a new type of pond weed from the Oligocene strata of Hordle Cliff in Hampshire. His remarks, which were listened to with great interest, were elucidated with the aid of diagrams, and were criticised by Mr. W. Carruthers and others.—Mr. J. E. Harting exhibited some dried plants of a so-called Greek tea (*Sideritis theezans*, Boissier), which during a recent visit to Thessaly he had found to be extensively used there, as an infusion in lieu of tea. He also exhibited some photographs of Thessalian scenery, showing the geological and botanical character of the country bordering the great plain of Larissa.—Dr. Otto Stapf pointed out on the map the scene of Bornmueller's recent botanical explorations in Persia, and gave some account of the flora of that region as far as has at present been ascertained.—On behalf of Mr. C. B. Plowright, a paper, communicated by the President, was read on the life history of the Æcidium on *Paris quadrifolia*.—On behalf of Mr. J. C. Willis, who was unfortunately prevented by illness from attending, a paper was read entitled "Contributions to the natural history of the flower." This paper, the first of a series, dealt with the fertilisation by insects of plants belonging to the genera *Claytonia*, *Phacelia*, and *Monarda*.—Some observations on British worms, by the Rev. H. Friend, were read on his behalf by the Secretary.

Royal Meteorological Society, February 15.—Dr. C. Theodore Williams, President, in the chair.—The following papers were read:—Report on the phenological observations for 1892, by Mr. E. Mawley. The Royal Meteorological Society has for a number of years past collected observations on natural periodical phenomena, such as the date of the flowering of plants, the arrival, song, and nesting of birds, the first appearance of insects, &c. These observations were supervised and discussed by the Rev. T. A. Preston until 1888, since which time they have been under the direction of Mr. E. Mawley. The year 1892 was on the whole very cold and backward. The frequent frosts and dry weather during the first five months greatly retarded vegetation, and consequently all the early wild flowers were very late in coming into blossom. Bush fruits and strawberries were, as a rule, good and fairly plentiful. Plums and pears were almost everywhere a failure, and apples were considerably under the average. The wheat crop was a very light one, owing in part to the attacks of blight brought on in many places by the frost in June. Oats, beans, and peas were much under the average, while barley was the chief crop of the year. Potatoes, turnips, and mangolds were above the average. During August butterflies were very numerous, the clouded yellow butterfly being exceptionally abundant.—Relation between the duration of sunshine, the amount of cloud, and the height of the barometer, by Mr. W. Ellis. This is a discussion of the observations made at the Royal Observatory, Greenwich, during the fifteen years 1877-91, from which it appears that in the months from February to October there is, on the whole, a distinct probability of increased sunshine and correspondingly less cloud with increase of barometer reading. The winter in all conditions of the barometer is uniformly dull. Mr. Ellis says that it is evident that high barometer in summer presages increased sunshine, that the effect is less pronounced in early spring and late autumn, and that it becomes slightly reversed in winter.—Winter temperatures on mountain summits, by Mr. W. Piffe Brown. In this paper the author gives the lowest winter temperature on the summit of Y Glyder fach, four miles E.N.E. from Snowdon, and 3262 feet above sea level, as recorded by a minimum thermometer during the last twenty-five years. The lowest temperature registered was 9° during the winter 1891-2.

Zoological Society, February 14.—Osbert Salvin, F.R.S., Vice-President, in the chair.—The secretary read a report on the additions that had been made to the Society's menagerie during the month of January 1893.—Prof. G. B. Howes exhibited and made remarks on an abnormal sternum of a Marmoset (*Hapale iacchus*) in which the mesosternal elements of the opposite sides were distinct, and alternately disposed, and discussed its probable bearings upon the sternum of the Anthropomorpha, particularly as represented by the orang.—Prof. T. Jeffrey Parker, F.R.S., read a paper on the cranial ostelogy, classification, and phylogeny of the *Dinornithidæ*. The author gave a detailed description of the skull in various genera and species of Moa, founded upon the examination of more than 120 specimens. A detailed comparison with the skulls of the other Ratitæ followed, as well as an extensive series of measurements.—The bearing of the facts ascertained upon the classification of the family was discussed. The author recognised five genera of *Dinornithidæ*, arranged in three subfamilies as follows: Subfamily DINORNITHINÆ, genus *Dinornis*; subfamily ANOMALOPTERYGINÆ, genera *Pachyornis*, *Mesopteryx*, and *Anomalopteryx*; subfamily EMEINÆ, genus *Emeus*. The phylogeny of the group was then discussed. *Mesopteryx* was considered to be the most generalised form, while *Dinornis* and *Emeus* were both highly specialised, but in different directions. Of the other Ratitæ, *Apteryx* came nearest to the Moas in the structure of its skull, and strong affinities were shown to the New Zealand genera by *Dromæus* and *Casuarius*. *Struthio* and *Rhea*, on the other hand, showed no special affinities, so far as the skull is concerned, either to the Australasian forms or to one another.—Mr. R. Lydekker read a paper on the presence of a distinct coracoidal element in adult sloths, and made remarks on its homology. It was shown that in two skeletons of sloths in the British Museum the shoulder-girdle exhibited a distinct coracoidal element. This element, like the coracoid process of the human scapula, was correlated with the precoracoid of the lower vertebrates; and the question was then discussed as to the name by which it should properly be called.—A communication was read from Dr. G. Radde, containing an account of the present range of the European bison in the Caucasus.

OXFORD.

Junior Scientific Club, Feb. 17.—In the Morphological Laboratory.—The President in the chair.—Mr. A. L. Still gave an exhibit of a variety of a common pheasant, which was shot near Croydon. This proved to be an extremely light-coloured young cock.—Mr. H. Balfour gave an exhibit of some modern Klepsydræ, such as are now used in guard rooms in many parts of Northern India and Burmah. He also showed some water clocks from Burmah, one of which was of interest as having come from the Imperial Palace of Mandalay, where it was the public standard of time.—Dr. Leonard Hill read an account of his researches on the gas evolved from muscles.—Mr. H. V. Reade read a paper on consciousness, and the unconscious, citing several cases of dual personality, and showing that memory could be explained by purely physiological reasoning.

EDINBURGH.

Royal Society, February 6.—Sir Arthur Mitchell, K.C.B., Vice-president, in the chair.—Mr. John Aitken read a paper on the particles in fogs and clouds. In a paper read some time since on the water particles in clouds, Mr. Aitken came to the conclusion that there was a relation between the density of the clouds and the number of water particles present. In May last year he made further observations, and got results opposite to the former. Instead of the density being nearly proportional to the number of water particles present, it was much short of proportionality, and the particles were small in size. Mr. Aitken points out that the size of the particles of water changes with the age of the clouds, and concludes that his first observations were made upon old clouds, while the latter series were made upon newly-formed clouds. He also considered the question of the persistence of fog-particles. There are two kinds of fog. In one the particles tend to persist, in the other they do not. That is, in one case, change of size of the particles takes place rapidly; in the other it does not. In town fogs it is not so much the number of dust particles that is of importance as their composition. If town dust were composed of particles having an affinity for water the fogs would have shorter duration.—Sir Douglas Maclagan described and explained an apparatus designed by Mr. J. Buchanan Young, Public Health Laboratory, Edinburgh University, for counting bacterial colonies in roll cultures.—A note, by Prof. Anglin, on properties of the parabola, was read.—Mr. A. J. Herbertson read a preliminary note on the hygrometry of the atmosphere at Ben Nevis. He finds that the observations already made agree well with the formula $y = ax + bw + c$; where y is the difference between the readings of the dry and wet bulbs, x is the temperature of the dry bulb, w is the weight of moisture per litre, and $a\ b\ c$ are constants.

DUBLIN.

Royal Dublin Society, January 18.—Prof. W. J. Sollas, F.R.S., in the chair.—Dr. J. Joly, F.R.S., read a paper on the cause of the bright colours of Alpine flowers. The conditions of insect life upon the higher Alps are referred to in this paper as bearing upon the question. Observations made by the author show that many thousands of bees and butterflies frequently perish in the cold of night-time on Swiss glaciers and firns. The author advocates the view that the scarcity of fertilising agents promotes a struggle for existence in the form of a rivalry to attract the attention of the fewer fertilisers by vivid colouring.—Prof. G. A. J. Cole read a paper on *Hemitrypa hibernica*, M'Coy.—A paper was read on a suggestion as to a possible source of the energy required for the life of bacilli, and as to the cause of their small size, by Dr. G. Johnstone Stoney, F.R.S., Vice-President.—Prof. W. J. Sollas, F.R.S., read a paper on the law of Gladstone as an optical probe.

February 22.—Prof. W. J. Sollas, F.R.S., in the chair.—Mr. Thomas Preston read a lecture note on the principle of work, showing that since the virtual work of a force is equal to the movement of an equal force at right angles to it, the principle of virtual work follows immediately as a corollary to the theorem of movements.—Prof. D. J. Cunningham, F.R.S., communicated a paper by Prof. A. M. Paterson on the human sacrum.—Prof. A. C. Haddon communicated a paper by Miss Florence Buchanan on *Eunice phylocorallia*, n. sp., commensal with *Lophohelia prolifera*.

PARIS.

Academy of Sciences, February 20.—M. de Lacaze-Duthiers in the chair.—Description of an instrument to show the small variations in the intensity of gravitation, by M. Bouquet de la Grye. The instrument, which has been set up in a cellar of the Dépôt de la Marine, consists of an iron tank containing hydrogen confined over mercury, with three tubes leading out through the bottom. Two of these tubes are bent upwards to about 40 cm. above the ground. One of them is used for filling the tank with mercury, the other for letting in the hydrogen, which is accomplished by letting mercury run out through the third pipe at the bottom. The second pipe ends in a horizontal tube made of glass, through the walls of which the fluctuations of the column of mercury sustained by the elastic force of the hydrogen can be observed. By means of an alcohol thermometer immersed in the mercury on the top of the tank, changes of temperature of one-thousandth of a degree are indicated by a movement of 1 mm. The column oscillates with each change of temperature and each variation of gravitation, but is not affected by changes of pressure, since the tube is kept closed at the top. Under these circumstances, the instrument in question is capable of indicating the change of gravitational force due to the change in the position of the moon by a displacement of 0·46 mm. The apparatus is difficult to set up, and will require some improvement before it can give trustworthy results. —Observation on the conditions which appear to have obtained during the formation of meteorites, by M. Daubrée. The heterogeneous structure of meteorites, the innumerable iron granules disseminated through the stony matrix, so different from the well-defined and voluminous crystals obtained by the fusion of the constituent minerals in the laboratory, and M. Stanislas Meunier's success in imitating meteorites by means of gaseous reactions, lead to the conclusion that they have not been produced by fusion, but by a sudden precipitation of different gases into the solid state.—On the preparation of uranium at a high temperature. Rapid preparation of chromium and manganese at a high temperature, by M. Henri Moissan (see Notes). —On stereochemistry, by M. C. Friedel.—On the benzoates and metanitro-benzoates of diazoamidobenzene and para-diazoamidotoluene, by MM. A. Haller and A. Guyot.—High atmospheric pressures observed at Irkutsk from January 12 to 16, 1893, by M. Alexis de Tillo. During four days the barometer remained above 800 mm., and on January 14 the highest value known up to the present, 807·5 mm., was reached, the temperature being $-46^{\circ}\cdot3$ C.—M. Callandreau was elected Member in the place of the late Admiral Mouchez; and M. Kékulé Correspondent in the place of the late M. Stas.—Summary of solar observations made at the royal observatory of the Roman College during the last quarter of 1892, by M. P. Tacchini.—On the terms of the second order resulting from the combination of aberration and refraction, by M. Folie.—On the essential singularities of differential equations of a higher order, by M. Paul Painlevé.—Remarks on the preceding communication, by M. É. Picard.—On uniform integrals of linear equations, by M. Helge von Koch.—Generalisation of Lagrange's series, by M. E. Amigues.—On the part played by the steam jacket in multiple expansion engines, by M. A. Witz.—A direct-reading stereo-collimator, by M. de Place.—Hysteresis and dielectric viscosity of mica for rapid oscillations, by M. P. Janet. A comparison of differences of potential and resulting charges during rapid oscillations, determined by means of the apparatus described last year, reveals a lagging of the charge behind the potential, both increasing and decreasing, and a curve plotted with the values obtained for a mica condenser suggests some analogy with Ewing's curves of magnetic hysteresis.—Optical field, absolute, and relative field of view of the human eye, by M. C. J. A. Leroy.—On the achromatism of semicircular interference fringes, by M. G. Meslin.—A new system of atomic weights, partly founded upon the direct determination of molecular weights, by M. A. Leduc.—Decomposition of the alkaline aluminates by carbonic acid, by M. A. Ditte.—On mixtures of ether and water, by M. L. Marchis.—On the heat of formation of arragonite, by M. H. Le Chatelier.—On the crystalline forms of chromium and iridium, by M. W. Prinz.—Ammoniacal fermentation of earth, by MM. A. Muntz and H. Condon.—On the composition of the salts employed as condiment by the people about the Oubangui, by MM. J. Dybowski and Demoussy.—Oxyhæmatine, reduced hæmatine, and hæmochromogen, by MM. H. Bertin-Sans and J. Moitessier.—On the histological alterations of the cerebral cortex in certain mental diseases, by M. R. Colella.—On the structure and growth of the calcareous shell of the barnacle (*B. tintinnabulum*), by M. Gruvel.—On the causes of the green colour of oysters, by M. S. Jourdain.—Geological remarks on the diamond-bearing meteoric irons, by M. Stanislas Meunier.

AMSTERDAM.

Royal Academy of Sciences, January 28.—Prof. van de Sande Bakhuysen in the chair.—Mr. Kapteyn dealt with the distribution of stars in space. It has been long known that the mean proper motion in the galaxy is smaller than elsewhere. A thorough investigation of the proper motion of *all* the stars of the Draper catalogue observed by Bradley in both co-ordinates (2357 stars) shows, that this fact is due to an excess of insensible or very small proper motion in the milky way. Those exceeding $0''\cdot055$ show no aggregation towards that zone. As far as the evidence goes, it further proves, by means of the angle subtended by the solar motion in space, that stars with equal proper motion *in* and *out* of the galaxy have nearly equal distances. These two facts taken together prove that Struve's theory of the arrangement of the stars in space must be abandoned. In order to find what arrangement must be substituted Mr. Kapteyn has considered the stars of the first and second spectral type separately, and arrives at the conclusion that the latter are very strongly condensed about a centre not far from our system, approximately in the direction of oh. R.A. and $+42^{\circ}$ of decl., whilst the stars of the first type are more nearly evenly distributed in the proximity of our sun. Notwithstanding this difference in arrangement Mr. Kapteyn thinks that probability points to the conclusion that the two types belong to one and the same system:—(1) Because the centre of condensation of the second type stars coincides very nearly with the apparent centre of the milky way (which seems to consist mainly of first type stars). (2) Because the stars with *insensible* proper motion of *both* types are strongly condensed towards the plane of the milky way. (3) Because groups of stars, which undoubtedly form stellar systems (*e.g.* Hyades) contain stars of both types.—Mr. van Bemmelen, in pursuing his inquiry on colloidal hydrates, spoke at the meetings of November 26, 1892, and of January 28, 1893, on the constitution and composition of the hydrogels of S_1O_2 and of CuO, as these result from his determinations of their tension of vapour (at 15°), changing in a continuous way with their tenure of water. —Mr. Kamerlingh Onnes showed the isodynamics of a new physical laboratory at Groningen, mapped under Prof. Haga's direction with the localvariometer by Mr. Wind, proving the excellent constancy of the magnetic field. A new theory of the localvariometer points to another ratio of distances of the deflecting magnet-pairs than that given by Kohlrausch as preferable. —Mr. Schoute treated of "the uniform representation of a cubic surface on a plane." Indication of the number of points common to two curves on F^3, the plane representations of which are given. Application as to the position of the twenty-seven lines with respect to one another.

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