THURSDAY, MAY 22, 1879

MILNE'S CRYSTALLOGRAPHY

Notes on Crystallography and Crystallophysics. By John Milne, F.G.S. (London: Trübner and Co., 1879.)

THAT two little treatises should have appeared, written at so near a date the one to the other as Mr. Gurney's and Mr. Milne's introductory tracts on crystallography, shows that there is at least some want at last beginning to be felt for the means of studying that important but somewhat neglected science.

And it is suggestive of some singular reflections that one of these little treatises should come from Japan written by one of that teaching body at Yedo, of which Prof. Perry is a distinguished member.

Is there a demand springing up among the subjects of the Mikado for branches of knowledge which have hardly obtained a footing in institutions in which scientific training is given in Great Britain? Or is it that the Japanese have enticed to their colleges Englishmen who are so far ahead of their colleagues at home, that they are less trammelled by routine, and endeavour in the instruction they give to the youth of Japan to work out a more complete and comprehensive curriculum for the student of chemical science and physics than is recognised at home? Whatever be the cause, we have, in Mr. Milne's little treatise as we had before in Mr. Gurney's, an attempt to supply an educational want. We must award to Mr. Milne all the credit which is his due for the intention this attempt involves, and for his courage in undertaking it, with what was apparently a small and inadequate equipment either in previous study or in the literary material necessary for making his treatise thorough and worthy of the purpose that suggested it. The book is concise and its form fairly well planned; and if our praise cannot be extended to the execution of that plan the circumstances under which the little volume has been produced have to be considered in extenuation of the dispraise. But in criticising it, it is essential to consider its seventy pages solely on their merits. Like Mr. Gurney, Mr. Milne follows Prof. Miller's system of crystallographic notation, and endeavours to make clear the simplicity and elegance of that system. His first line, however, in explanation of the system, the sixth line of his Introduction, is, to say the least, infelicitous. "In this (Miller's) system," he says, "the symbols of a face consist of three whole numbers, each of which invariably refer to the same axes;" a sentence in which are compendiously represented the faults of the book, faults due partly to inaccuracy of mathematical conception, and partly to a mode of employing the English language, for which perhaps some excuse is to be found in a long residence in Yedo, but which surely one of the three home-editors, Mr. T. Davies, Mr. H. Woodward, and Prof. Morris, might have taken the liberty of correcting.

What Mr. Milne intended to convey in the above ungrammatical sentence was, of course, that the symbol for a plane is constituted by three whole numbers termed indices, which may include one or two zeros; the particular axis to which an index has reference being given by the position of the index in the symbol. If Mr. Milne would, for instance, consider the application of his statement to the symbols for the faces y, y', &c., of the crystal of cuprite, which he discusses on p. 27, and where by the by he makes the blunder in his result of putting (015) for (051), he would find that his statement amounts to the assertion that these two last symbols are identical, an assertion that would reduce the system of Miller to all the ineptitude of that of Naumann.

In deducing on p. 16 the symbol of a zone from the symbols of the planes belonging to it the author proceeds on the tacit assumption that he has rectangular axes to deal with, thus leaving unexplained the case of crystals belonging to systems referred to oblique axes; and these form a large majority of the known crystals.

In his mode of treating the problem by algebraic geometry in the last paragraphs on p. 17 he is certainly not to be congratulated.

It is from this p. 17 that one begins to find the hopelessness of this little book fulfilling, in its present crude form, the purpose its author proposes for it; that, namely, of making the simple system of F. Neumann and Miller intelligible either to the student slenderly equipped with mathematical knowledge, or to the votary, too often the partizan of the system of K. Naumann.

For it is evident that Mr. Milne has been unfortunate in his English editors. Mr. T. Davies, a gentleman universally esteemed for his personal character as well as for a very complete familiarity with minerals and rocks, obtained by the daily handling and scrutiny of them during twenty years of service in the British Museum, undertook, it seems, to pass through the press the little book of which copies lithographed by a Japanese native had been sent home to him and to others by Mr. Milne. If Mr. T. Davies had enlisted the aid of some one who possessed a rudimentary knowledge of algebra and plane trigonometry he might have saved Mr. Milne's little book from being useless. Then probably $\infty - 01$; $\infty - 10$; $11 - \infty$ would have been written $0 \times 0 - 0 \times 1$, &c., and would have been intelligible, and such a misprint as that on p. 21, "$\therefore$ (112) being (*sic*) the indices of the plane at $\perp s$ to [111] and [110]," might have been avoided. Of course a plane $\perp^r$ to [111] and [110] is ($\bar{1}10$) or ($1\bar{1}0$) and not (112); but Mr. Milne meant to write the two zones as [11$\bar{1}$] and [$\bar{1}$10]. Misprints of this serious kind are very numerous; other instances are (loh) for ($lo\bar{h}$), (orq) for ($or\bar{q}$), or $(p - s)$ for $o, r(p - s)$ on p. 22; $\lfloor Wvw$ for UVW on p. 24; [312] twice for [$\bar{3}$12] on p. 26; the frequent omission of brackets where they are necessary: for instance, $a^2kr - lq$ instead of $a^2(kr - lq)$ on p. 17; and these are the sort of errors which puzzle a student who is not a fair mathematician, precisely the student for whom the book is meant, since any one possessed of a little mathematical knowledge would naturally prefer to have recourse to Miller's Tract on Crystallography, a book of the existence of which Mr. Milne seems to be unaware, to judge from a note on p. 34. In a treatise on a science which presents to the student novel forms of notation the want of even the most elementary acquaintance with algebra that has allowed the introduction into the type, of

a comma to represent the sign of multiplication in almost every equation, invests the expressions with a hopeless obscurity; what for instance would a young student fresh from a little algebra make of the expression (p. 30), cos PC = cos PA, cos CA + sin PA, sin CA, cos PAC whence PC? Mr. Milne's editors and not Mr. Milne are of course to blame for this, though most of the other mistakes alluded to are his own.

In a chapter on the projection of poles by the stereographic method Mr. Milne gives a proposition for finding a pole [he means the projection of a pole] at given angular distances from two poles lying on the circle of projection, which is only a special and simple case of the more general problem. The description of the process is entirely unintelligible. If, however, the meaning be puzzled out from the figure it would seem that Mr. Milne is proposing a construction simple and ingenious, although to obtain it he has to combine the orthographic and stereographic projections. His editors might have saved him from using the expression "two half-hemispheres" on p. 38, if not also from the statement that the monosymmetric or monoclinic system can present eight faces for a single form. The chapter on crystallophysics is very unsatisfactory; after one's expectations of somewhat transcendental physics have been raised by being told that for the correlation of the phenomena produced by crystals with crystal-structure, "the most valuable hypothesis would probably be that of molecular vortices," one is certainly surprised to be told that in the orthorhombic, monoclinic, and triclinic systems "there are two optic axes or directions of double refraction"—or again, that "sections in triclinic crystals cut perpendicularly to the optic axes when viewed in a polariscope show a series of rings round each axis. Between the axes these are drawn together and may meet to form a lemniscate." One is inclined to ask whether Mr. Milne has a distinct idea as to what a lemniscate curve is, and how he cuts the section presenting these phenomena?

In speaking of heat conductivity again, the author places the rhombohedral and orthorhombic systems together in one category, and the tetragonal system in another. The errors, often arising in carelessness but sometimes in ignorance, to which these criticisms apply, have been selected merely at random. It has been necessary, however, to make these criticisms in the interest of the student, who might be repelled from a subject when he finds what should be a simple statement apparently untrue or unintelligible, whether on account of misprints or of obscurity in the language, in the thought, or in the author's method of demonstration. But having performed this duty to the student of a beautiful but much neglected science it would be ungenerous to a teacher in far Japan, not to point out that it is still within his power by recasting his little volume to fill a decided gap in our elementary scientific literature. He has the courage and the ability, he needs only a little more familiarity with the subject, a good deal more caution, and perhaps somewhat more of modesty, to enable him to fulfil the not very ambitious purpose he laid down for himself when he sent his little work to be published in England.

N. S. M.

MATHEMATICAL PROBLEMS

I. *Mathematical Problems on the First and Second Divisions of the Schedule of Subjects for the Cambridge Mathematical Tripos Examination.* Devised and arranged by Joseph Wolstenholme, M.A. Second Edition, greatly enlarged. (London: Macmillan and Co., 1878.)

II. *Solutions of the Cambridge Senate-House Problems and Riders for the Year* 1875. Edited by A. G. Greenhill, M.A. (Same Publishers, 1876.)

III. *The Same for the Year* 1878. Edited by J. W. L. Glaisher, F.R.S. (Same Publishers, 1879.)

IV. *Graduated Exercises in Plane Trigonometry.* Compiled and arranged by J. Wilson, M.A., and J. R. Wilson, B.A. (Same Publishers, 1879.)

V. *Geometrical Deductions, Riders, and Exercises, based upon Euclid, Books I.—IV.* (Stewart's Mathematical Series, 1878.)

A COMMON purpose pervades these five works, viz., that of affording practice and aid in the solution of mathematical problems. Prof. Wolstenholme, with a marvellous versatility which has long placed him in the foremost rank of "ten-minute conundrum" makers, sends forth a volume (I.) which now contains 2,815 problems in place of the 1,628 which he published in 1867. Further, his book has increased in all the directions in which it is possible for a book to grow, and the number of valuable hints scattered throughout the volume has been greatly enlarged. Dipping into the book here and there we are fain to cry out "Prodi-gi-ous!" with worthy Dominie Sampson, and to think this problem-compelling Briareus ever

> "Agitates his anxious breast,
> In solving problems mathematic."

We have long used the earlier work with profit to ourselves, and, we believe, to the advantage of our pupils preparing for Cambridge scholarship examinations; this new edition is an improvement upon the old, and in its line seems now perfect. What we would much like to have is Prof. Wolstenholme's solutions of his questions, but we fear the public, needed for the purchase of such a work, is not yet in existence. Doubtless there are many errors in the text, but these can only be found out by a free and long-extended use; however, we have noted in question 443, for the second $\cos^3\theta$ read $\sin^3\theta$; question 925, for a ? $2a$; p. 192, lines 2, 5, put – before Δ.

In the volumes II., III., we have a welcome revival of a fashion which has of late years died out; it never prevailed to any great extent, but its occurrence was generally traceable to the influence of some one or two enthusiasts, who, for the benefit of junior students, were willing to put upon record neat solutions of elegant problems, not counting the cost of publication. Such collections as these are especially valuable, and the volumes before us seem quite equal to their predecessors in the same field. A novelty in III. is the publication of additional remarks on some of the questions. For instance, a concise general statement of the method of least squares is given on pp. 162-169; on p. 8 is a note on circulating decimals, and similar notes occur elsewhere. In this work (III.) we have detected several small errors, p. 13 line 14 insert – before $\frac{3}{16}a^2$; p. 14

there are three errors; p. 147, line 7, dele "is *r*," there are two other errors on this page; p. 187 we have a vague reference to Boole's Differential Equations, and a misprint lower down; there are other minor errors easily detected, but when correcting pp. 114 to 116, somebody must have had his eyes shut at times or he would not have passed such a number of clerical errors.

In IV. we have a fresh work, well adapted for the higher forms in schools, though the examples are in some cases difficult. There are good notes, and the whole book may be recommended to students reading for scholarship or for college terminal examinations. We could put our finger upon many a mistake easily detected by an advanced student, so that we should advise junior pupils not to spend too long a time upon the questions if they do not succeed in getting the same answer as is given in the text. In making this statement we are bound to say that the number of mistakes seems to be no greater than is almost inevitable in a first edition.

The manual V. contains "more than 160 deductions which have been set at public examinations, worked out in full as examples, together with a collection of specimen examination papers, which have been set at the examinations, Cambridge Mathematical Tripos, London University Matriculation, &c." This fuller title gives a good idea of the scope of the work: it aims at doing for junior students what is done for higher students by McDowell's exercises on Euclid and in Modern Geometry. We have only been able to look into the book casually; we have found the parts so examined correct and put in such a way that a lad acquainted with the text of Euclid ought to have no difficulty in following the proofs here given. The student has to draw his own figures. The printing is good and so done as to assist the reader in his work. From the initials attached to the preface we should infer that the compiler is Mr. A. T. Fisher, whose "Book of Algebra" in the same series we commended, at the time of its publication, in these columns.

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. No notice is taken of anonymous communications.*

[*The Editor urgently requests correspondents to keep their letters as short as possible. The pressure on his space is so great that it is impossible otherwise to ensure the appearance even of communications containing interesting and novel facts.*]

Spectrum of Brorsen's Comet

I HAVE to thank Dr. Marshall Watts for having called attention to a point of some interest with regard to the spectra of comets, viz., which of the carbon spectra agrees with the cometary spectrum? In the case of Brorsen's comet the most important question was, whether the spectrum differed *largely* from that of other comets, as found by Dr. Huggins in 1868, and not having much leisure at the time of writing to examine the question of the different spectra of carbon, I overlooked the circumstance that the comparison spectrum used by Prof. Young was the first or flame spectrum of carbon. The difference, however, in the positions of the bands in the two spectra of carbon is a quantity which it is not very easy to answer for in the case of a faint cometary spectrum, and it is but a small fraction (less than one-fourth) of the discordance between Dr. Huggins's measures in 1868 and those made at the present return of the comet.

In the comparisons made at Greenwich the induction-spark (without Leyden jars) was taken in a vacuum-tube containing alcohol vapour at a pressure of 1·2 mm., and the green comet-band was compared with this spectrum exactly in the manner described by Dr. Watts, though practical difficulties of manipulation prevented our making comparisons with the flame spectrum, as I wished. In fact the awkward position of the spectroscope in observing the comet below the pole made the observations extremely difficult, and caused great loss of time, so that the results are not so numerous as they would otherwise have been. On April 17 I used a micrometer eye-piece, with a movable bar, the breadth of which corresponded to 30 tenth-metres, whilst the slit was of such a width that the line with which the band in the alcohol-spectrum commences was 45 tenth-metres broad. The bar was brought up from the blue end so as just not to hide the less refrangible edge of the comet-band; the spectrum from the alcohol vacuum-tube was then flashed in, and the less refrangible edge of the carbon-band was found to be just visible beyond the bar. Several comparisons were made in this way, and I estimated that the uncertainty in the determination of the coincidence between the less refrangible edges of the comet and carbon-bands was but a small fraction of the breadth of the bar (30 tenth-metres). I did not obtain any micrometer readings. On April 19 and 28 Mr. Maunder, from readings with a bright-line micrometer, found for the position of the bright edge of the comet-band in the green, compared with the centre of the line at the edge of the alcohol-band (wave-length, 5198·3):—

	Comet-band. Tenth-metres.	Wave-length inferred.	Width of Slit.
April 19	0·5 to blue	5190	0·009 in. = 16 tenth-metres.
28	4·5 to red	5191	0·013 ,, = 24 ,,

In computing the wave-length of the bright edge of the comet-band, half the breadth of the alcohol-line (= width of slit) has been applied. In a similar manner the wave-length of the bright edge of the comet-band in the yellow was found to be 2·4 tenth-metres to the red of the edge of the alcohol-band at 5610·5, or at 5580, allowing for the width of the slit, which was 0·033 in. or 65 tenth-metres. The position of the blue band was estimated to be *approximately* coincident with the blue band of alcohol at 4834, but this determination is very rough indeed. The dispersion used was that of one "half-prism," viz., 20° from A to H, equivalent to four flint prisms of 60° with a magnifying power of twelve. In my former letter I, by mistake, gave the dispersion as equivalent to two prisms only, instead of four. The high dispersion used is of course an important element in estimating the accuracy of the determination, and on comparing afterwards the flame and vacuum-tube spectra of carbon with the width of slit and other conditions of observation the same as on April 17 and 19, I found the two bands so widely separated that it appeared impossible to mistake one for the other in estimating a coincidence. I may add that the spectrum of Coggia's comet also was found to be identical with the second spectrum of carbon. With regard to Dr. Huggins's observations of Comet II. 1868, and Coggia's comet, Dr. Watts does not give his reasons for the assertion that the comparison spectrum was the first spectrum of carbon. According to the diagram given by Dr. Huggins, the spectrum in olefiant gas is distinctly different from that in olive oil, which I presume is the first spectrum, and the comet-spectrum agrees with the former. As far as I can judge, this is the spectrum which we have obtained in vacuum-tubes, whether they contain alcohol, carbon-oxide, carbon-dioxide, or olefiant gas. I do not wish to enter on the question as to whether the differences in the carbon-spectra result from differences of chemical composition or of molecular condition depending on temperature, though I may remark that the same vacuum-tube gives quite a different spectrum when Leyden jars are introduced into the circuit.

W. H. M. CHRISTIE

Royal Observatory, Greenwich, May 17

End-on Tubes, brought to Bear upon the Carbon and Carbo-Hydrogen Question

IN NATURE, vol. xx. p. 28, there is an important paper by Dr. Marshall Watts, touching certain recent observations of carbon spectra so-called, which seems to offer an excellent opportunity for clearing up certain long-disputed points in spectroscopy, and to the satisfaction, I hope, of every one.

Firstly, the Doctor alludes to the recent happy case of Prof. Young, of Princeton, U.S., having last month compared the green band of Brorsen's comet with the green band of a Bunsen gas burner, and found them identical in spectrum place, thereby

bringing the said Brorsen's comet into line with most other comets, as to possessing both that band and material.

Secondly, Dr. Watts alludes to Mr. Christie, of the Royal Observatory, Greenwich, having also recently observed the spectrum of the same comet, and stated that he had thereby found the *same* result as Prof. Young. But the Doctor implies there must be some mistake therein, because—what Mr. Christie compared the sharp edge of the comet's green band, with, and found it coincident, was not the Bunsen gas burner's green band, but that of an alcohol vacuum tube illumined by electric spark; and this latter green band, he says, is in an absolutely different spectrum-place to that occupied by the coal-gas burner's green band.

The first answer here, is both pleasant and simple. I know perfectly well what it is the Doctor alludes to, as being visible in the alcohol vacuum tube, but would beg to remind an accomplished laboratory worker that it is so close in spectral place to the coal-gas flame's green band, that in any spectroscope of very small dispersion, and when the subject is seen only faintly and at intervals in a difficult astronomical observation, such minute difference of place might well be disregarded in comparison with the enormous difference or anomaly of an older, almost historic, record, whose large discrepance, eight times larger than the other difference, was really the thing which both Mr. Christie and Prof. Young had before them, either to prove or disprove. And as they have now each of them independently assured us, by special observations at the end of a telescope in the cold night air, that the enormous anomaly suspected of old no longer exists—they both deserve our best thanks.

But next comes, for those who work in-doors with brighter lights and more powerful spectroscopes, the second part of the answer, with a proof that Mr. Christie, after all, may not have used a differently placed reference to Prof. Young's, even in the least degree, because, *besides* what Dr. Marshall Watts says very truly, there is in the spectrum of an alcohol vacuum tube electrically illumined, there is *also* a something else which he either has not seen, or has not yet recognised as such, but which is the very identical green band of the coal-gas flame in open air.

The special green band which the Doctor *has* seen and recognised in an alcohol vacuum tube is to be seen equally in vacuum tubes of all gases containing carbon in any combination, and is therefore abundantly visible in tubes of carbon monoxide, carbon dioxide, and cyanogen. This, too, is the spectrum which he calls the "Carbon spectrum No. 2," but which I call simply the spectrum of carbon; a spectrum which no one has yet found in any common candle flame, coal-gas flame, or comet in the sky; and it requires apparently the ecstatic heating of the electric spark for its smallest development.

But the other green band, which I shall presently prove is also in an alcohol vacuum tube, though the Doctor may not have recognised it there, he has seen abundantly elsewhere, for it is found in the blue base of every candle, lamp, or coal-gas flame, and he has given the spectrum place of the beginning of it with exceeding accuracy. In fact, the only unhappy thing is, that he will look upon it as pure carbon, calling it the "Carbon spectrum No. 1," when it is so evidently the compound "carbo-hydrogen;" for with my new end-on tubes, while I do *not* see *this* green band in vacua of either carbo-oxygen or carbo-nitrogen (unless ultra-faintly as a trace of impurity), I do see it, and most brilliantly, in tubes of such rich carbo-hydrogens as alcohol and olefiant gas.

Now it is not a little singular as a coincidence merely, that I was actually engaged only yesterday, after an interval of several years, in pointing out to my friend Prof. Swan, of St. Andrews, the existence of "his" carbo-hydrogen blow-pipe flame's lines of its green band, projected upon, and differently placed from, the true elemental carbon green band of an alcohol vacuum tube, electrically illumined; and we proceeded thus to test the identity of what I called "his" flame lines, by a close proof of place, which is everything in spectroscopy.

A coal-gas and air blow-pipe flame, end-on, was set up before the spectroscope on one side of the table, and on the other side an alcohol vacuum tube, illuminated by 1-inch sparks from a small coil, and viewed also end-on. The spectroscope could be rotated easily in azimuth by endless screw motion, so as to look with its gathering telescope first into the tube, then into the flame, and then again into the tube. The prism train had the large dispersion of 33° between A and H, the telescope a magnifying power of 10, and its pointer was one of Mr. Hilger's latest and most refined steel wedges of almost infinite sharpness.

The slit was made exceedingly narrow, the definition in the centre of the field was super-excellent, and then Prof. Swan micrometrically bisected a certain thin but exceedingly bright line, which looked like an anomaly on the surface, and far within the least refracted edge of the elemental carbon green band of the alcohol tube, and clamped the pointer in that exact spectrum place.

I then rotated the whole instrument round to the blow-pipe flame, and asked him "What is the pointer on now?"

"On the first and brightest line of the blow-pipe flame's green band," he answered, "Alexander Herschel's green giant of carbo-hydrogen, and it is admirably bisected too."

We next rotated back to the alcohol tube, and found the pointer still accurately bisecting that bright line present there, which was a total anomaly in a pure carbon spectrum, though perfectly agreeable to what Prof. Swan wrote of the compound carbo-hydrogen's flame spectrum, twenty-three years ago. Most opportunely present also in that tube, for it enabled Mr. Christie to compare Brorsen's comet with the same identical reference as that used by Prof. Young, though employing an alcohol spark spectrum, and not a gas-burner.

The second line of the blow-pipe flame's green band, though much fainter, is also distinctly seen in the end-on view of the alcohol tube's spectrum, and answers perfectly to a similar test for place as the first line. Wherefore, I would beg to ask, how can I hold any other view than that carbon, as a pure chemical element, and the most refractory that is known, has no spectrum short of electric spark temperature; and what it then shows is, to exact measurement with large dispersion, a perfectly different spectrum to that of the compound gas, carbo-hydrogen; which compound gas, while still existing to some extent in the electric spark tubes, begins its spectral manifestations in the very moderate temperature of merely a farthing tallow candle: a matter to be duly considered in studying the physical condition of comets, which do not show any spectrum (or, for small and "uncondensed" sparks, we may say *the* spectrum) of pure elemental carbon.

PIAZZI SMYTH

Edinburgh, May 9

The Victoria University

IN the article on the Victoria University in the last number of NATURE, I observe some inaccurate statements regarding the Queen's University in Ireland.

In the first place there are not *four* colleges, but *three*. Next there are no *degree* examinations in any college, but all are conducted in Dublin by the examiners of the university, who, for the most part, are also professors in the colleges; but there are some examiners who are not professors, and also some professors who are not examiners.

A. J. C. ALLEN

Peterhouse, Cambridge

Maps of Old Geological Coast-lines, &c., &c.

I NOTICE in Woodward's "Manual of the Mollusca," when speaking of the "Boundaries of Natural History Provinces," p. 352, the following:—

"The seas are divided by continents and influenced by the physical character of coast-lines, by climates, and currents."

May not the occurrence of different species in different parts of contemporaneous strata help to determine the positions of land and water, &c., in past geological ages?

W. W.

Cambridge

[In reply to "W. W.'s" interrogatory, "May not the occurrence of different species in different parts of contemporaneous strata help to determine the positions of land and water, &c., in past geological ages?" we would say, Yes, most certainly; and it is not only by recording the occurrence of *different species*, probably peculiar to different zones of depth, that geologists have long tried to mark out old sea-beds, but more especially by tracing carefully *the occurrence* of the *same species* along extended lines of formations, they have attempted to map out old geological coast-lines. Much has been done in this direction by Godwin-Austen, Forbes, Quenstedt, Oppel, Waagen, Hebert, Oswald Heer, and many others; but much more remains to be accomplished, and "W. W." cannot do better than take up some such line of inquiry for his summer vacations. How much good field-work might be done in three months' holidays in, say, three successive years, with a knapsack on one's back and a hammer in one's hand, let the admirable papers by Dr. Chas. Barrois of Lille tell!—H. W.]

Note on the Iodobromite of A. v. Lasaulx

In the *Jahresberichte für Mineralogie* for 1878 A. v. Lasaulx has described a new silver haloid mineral, having the composition Ag_2Br_2, Ag_3Cl_2, AgI, or $Ag_5Cl_2Br_2I$, which he cites as the first instance of the three haloids occurring crystallised together in nature. Several chloro-bromides of silver have been found in Chili in the silver mines of Chañarcillo, and, according to Dana, an iodobromide has also been detected. The present mineral, which should be called *chlorobromiodide*, was found associated with beaudantite in a mine in the district of Ems, Nassau, in the form of small yellow or olive green octohedrons never exceeding 3 mm. in size. The crystals are very malleable, and can be pressed flat with the blade of a knife, and they possess a good deal of lustre. On analysis they were found to contain :—

Silver	59·96
Iodine	15·05
Bromine	17·30
Chlorine	7·09
	99·40

In 1876 I prepared some of this substance artificially by fusing together the chloride, iodide, and bromide in the proportions of AgI 26·1692, AgBr 41·8708, AgCl 31·9600, which gives an ultimate composition of :—

Silver	60·1336
Iodine	14·1435
Bromine	17·8176
Chlorine	7·9053
	100·0000

The substance was prepared with other chlorobromiodides of silver in order to see the extent to which iodide of silver (which contracts considerably when heated from 142° to 145·5° C.) modifies the coefficient of expansion of the chloride and bromide, which do not present similar anomalies. The results obtained are given in the *Proc.* of the Royal Society, vol. xxv. p. 294, 1877, "On the Effects of Heat on some Chlorobromiodides of Silver," and they are of additional interest now that the substance has been found in nature.

The compound artificially prepared is a brittle yellowish-brown solid, giving a bright primrose-yellow powder, which turns green on exposure to light. (It is noticeable that some of the crystals found by Lasaulx were yellow, others green.) It is a crystalline solid which emits loud harsh noises while cooling from the molten condition. The fusing point is 330° C. The sp. gr. 6·152 when cooled quickly, but when fused and allowed to cool slowly in hot paraffine, the sp. gr. fell to 6·066. A. v. Lasaulx makes the sp. gr. of the mineral as low as 5·713. The artificially prepared compound was found to possess a coefficient of cubical expansion for 1° C. = 0·00012216 between 0° C. and 125·5. Between 125·5 and 131·5 it underwent slight contraction, while between 131·5 and the fusing point the coefficient was 0·00015882. It possesses two points of similar density, the one at 131·5° C., the other at or about 123° C. The volumes calculated from the coefficients, taking volume at 0° C. as unity, were found to be :—

Volume at	0° C.	= 1·000000
,,	125·5°	= 1·015331
,,	131·5°	= 1·015037
,,	330°	= 1·046666 (solid)
,,	330°	= 1·104050 (liquid)
,,	750°	= 1·177979

It is presumable that the other artificially-prepared chlorobromiodides described in the paper cited above will also be found in silver mines.

G. F. Rodwell

Inherited Memory

Having had my attention called, of late, to the subject of the migration of birds, I have of course been interested in the discussion between Dr. Weismann and Prof. Newton, and I cannot help fancying that I have hit on the "missing link" which connects the theory of the former with the facts of the latter.

Are there not scientific men (and is not Dr. Carpenter one of them) who consider that when we say an event has made "such an impression on us that we shall never forget it"—we are not merely using a metaphor, but stating a fact? Now if something analogous to "making an impression" on the brain really takes place whenever we commit anything to memory—is it not possible that if the impression be deeply fixed, the impressed brain may be transmitted by the parent to the offspring, who thus "inherits" its ancestor's memory?

When we remember that birds take the same journey year after year, generation after generation, century after century, nay, even for ages after ages, I think we shall feel that there are more marvellous things in nature than what I am asking you to consider, namely, the possibility that the young bird at last inherits a knowledge of the way, and is capable of performing the journey alone.

If "inherited memory" be accepted as a fact, what a flood of light is thrown on many puzzles which have hitherto been classed as "instincts"; such as the building of birds' nests; the pointing of pointer puppies, the knowledge possessed by young animals of right and wrong food, and of friends and enemies; I am not sure that it will not even throw light on some mysteries in human nature. When I was a child I had a dread of wolves (a very common thing with children), and I find the dread reproduced in one of my own children. Yet wolves have been so long extinct in England that we should probably have to go back many generations before we met with the nurses who quieted crying children by threatening to give them to the wolves. May not this be a case of "inherited memory?" A. B.

Intellect in Brutes

Some years ago the late Hon. Marmaduke Maxwell, of Terregles, took me to his stable to show me a cat which was at the time bringing up a family of young rats. The cat some weeks previously had a litter of five kittens, three were taken away and destroyed shortly after their birth; next day it was found that the cat had replaced her lost kittens by *three* young rats which she nursed with the two remaining kittens; a few days afterwards the two kittens were taken away, and the cat very shortly replaced them by *two* more young rats, and at the time I saw them, the young rats—which were confined in an empty stall—were running about quite briskly, and about one-third grown. The cat happened to be out when we went into the stable, but came in before we left; she immediately jumped over the board into the stall, and lay down; her strange foster-family at once ran under her and commenced sucking. What renders the circumstance more extraordinary is, that the cat was kept in the stable as a particularly good ratter.

Cargen, Dumfries, May 9 P. Dudgeon

Phosphorescence

In regard to the effect of heat on phosphorescence, your correspondent in last week's number will find that almost similar phenomena have been observed by Dr. Draper, who treats of the whole subject very fully and satisfactorily in his "Scientific Memoirs." G. S. Thomson

Clifton, May 18

AN INDUCTION-CURRENTS BALANCE[1]

Immediately upon the announcement of Arago's discovery of the influence of rotating plates of metal upon a magnetic needle (1824), and Faraday's important discovery of voltaic and magneto-induction (1831), it became evident that the induced currents, circulating in a metallic mass, might be so acted upon either by voltaic or induced currents as to bring some new light to bear on the molecular construction of metallic bodies.

The question was particularly studied by Babbage, Sir John Herschel, and by M. Dové,[2] who constructed an induction balance, wherein two separate induction coils, each having its primary and secondary coils, were joined together in such a manner that the induced current in one coil was made to neutralise the induced current in the opposite coil, thus forming an induction balance, to which he gave the name of differential inductor. In those days physicists did not possess the exquisitely sensitive galvanometers and other means of research that we possess to-day, but sufficiently important results were

[1] "On an Induction-Currents Balance, and Experimental Researches made therewith." By Prof. D. E. Hughes. Read at the Royal Society, May 15.

[2] De la Rive, "Treatise on Electricity," vol. i. chap. v. (London, 1853)

obtained to prove that a vast field of research would be opened if a perfect induction balance could be found, together with a means of correctly estimating the results obtained. In experimenting with the microphone I had ample occasion to appreciate the exquisite sensitiveness of the telephone to minute induced currents. This led me to study the question of induction by aid of the telephone and microphone. The results of those researches have been already published.[1]

Continuing this line of inquiry, I thought I might again attempt to investigate the molecular construction of metals and alloys, and with this object I have obtained, after numerous comparative failures, a perfect induction balance which is not only exquisitely sensitive and exact, but allows us to obtain direct comparative measures of the force or disturbances produced by the introduction of any metal or conductor.

The instrument which I have the honour to present to the Royal Society this evening, consists (1) of the new induction-currents balance; (2) microphone, with a clock as a source of sound; (3) electric sonometer, or absolute sound measurer, a late invention of my own; (4) a receiving telephone and three elements of Daniells' battery.

In order to have a perfect induction-currents balance suitable for physical research, all its coils, as well as the size and amount of wire, should be equal. The primary and secondary coils should be separate, and not superposed. The exterior diameter of the coils presented this evening is 5½ centims., having an interior vacant circular space of 3½ centims., the depth of this flat coil or spool is 7 millims.

Upon this box-wood spool are wound 100 metres of No. 32 silk-covered copper wire. I use four of such coils, formed into two pairs, the secondary coil being fixed permanently, or by means of an adjustable slide, at a distance of 5 millims. from its primary; on the second similar pair there is a fine micrometer screw, allowing me to adjust the balance to the degree of perfection required.

These two pair of coils should be placed at a distance not less than 1 metre from each other, so that no disturbing cause should exist from their proximity.

The two primary coils are joined in series to the battery, the circuit also passing through the microphone.

In place of the telephone I have sometimes used a magnetic pendulum, the swing or the arc described indicating and measuring the forces.[2] I am at present engaged upon a very sensitive voltameter, which shall indicate and measure the force of rapid induced currents. The telephone, however, is well adapted as an indicator, but not as a measurer of the forces brought into action. For this reason I have joined to this instrument an instrument to which I have given the name of electric sonometer. This consists of three coils similar to those already described, two of which are placed horizontally at a fixed distance of 40 centims. apart, and the communication with the battery is so arranged that there are similar but opposing poles in each coil; between these there is a coil which can be moved on a marked sliding scale divided into millimetres; in a line with these two opposing primary coils, the centre coil is the secondary one, and connected by means of a circuit changing key with the telephone in place of the induction-balance. If this secondary coil is near either primary coil we hear loud tones, due to its proximity. The same effect takes place if the secondary coil is near the opposing coil, except that the induced current is now in a contrary direction, as a similar pole of the primary acts now on the opposite side of the induction-coil; the consequence is that as we withdraw it from one coil approaching the other, we must pass a line of absolute zero, where no current whatever can be induced, owing to the absolute equal forces acting equally on both sides of the induction-coil. This point is in the exact centre between the two coils, no matter how near or distant they may be. We thus possess a sonometer having an absolute zero of sound; each degree that it is moved is accompanied by its relative degree of increase; and this measure may be expressed in the degrees of the millimetres passed through, or by the square of the distances in accordance with the curve of electro-magnetic action.

If we place in the coils of the induction-balance a piece of metal, say copper, bismuth, or iron, we at once produce a disturbance of the balance, and it will give out sounds more or less intense on the telephone according to the mass, or if of similar sizes, according to the molecular structure of the metal. The volume and intensity of sound is invariably the same for a similar metal. If by means of the switching-key the telephone is instantly transferred to the sonometer, and if its coil be at zero, we should hear sounds when the key is up or in connection with the induction-balance, and no sounds or silence when the key is down or in connection with the sonometer. If the sonometer-coil was moved through several degrees, or through more than the required amount, we should find that the sounds increase when the key is depressed; but when the coil is moved to a degree where there is absolute equality, if the key is up or down, then the degree on scale should give the true value of the disturbance produced in the induction-balance; and this is so exact that if we put, say, a silver coin whose value is 115°, no other degree will produce equality. Once knowing, therefore, the value of any metal or alloy, it is not necessary to know in advance what the metal is, for if its equality is 115°, it is silver coin; if 52, iron; if 40, lead; if 10, bismuth; and as there is a very wide limit between each metal, the reading of the value of each is very rapid, a few seconds sufficing to give the exact sound-value of any metal or alloy.

During the course of these experiments with this instrument I noticed that my own hearing powers varied very much with state of health, weather, &c., that different individuals had wide differences of hearing, and that nearly in all cases one ear was more sensitive than the other; thus whilst my degree of hearing was 10°, another might be 60 in one ear and 15 in the other.[1]

Dr. Richardson, F.R.S., who upon my invitation investigated this subject, became so impressed with the value of the instrument as an absolute measurer of our hearing powers, and its capabilities of throwing much light upon its relation with health, that he has undertaken a series of researches which will extend over some time, and which I think, from some facts already gained, will be of great value to the medical profession. These experiments are now in his very able hands, and he will in due time announce the results to the Royal Society.

If an observer's hearing is limited to 10°, how can we hear results below this line? I should have stated that when used to measure the hearing power, we determine on a constant standard of force such as one element Daniell, but if we increase the number of elements we in the same ratio increase the inductive disturbance, and thus by a large increase of force bring within our range results too feeble to be heard without its aid, the sonometer constantly, however, giving the same degree for equality as the increased force is also used on this instrument. Thus in our measurements we can entirely neglect the amount of battery, as its comparative results remain a constant.

As a rule three Daniell elements will be found quite sufficient, and even this weak force is so exquisitely sensitive that it will find out the smallest fraction of difference in weight or structure of metals. Thus two silver coins such as a shilling, both quite new, and both apparently of the same weight, will be found to possess a

[1] *Comptes Rendus*, December 30, 1878, and January 20, 1879; Society of Telegraph Engineers, March 12, 1879.

[2] *Telegraphic Journal*, December 15, 1878.

[1] To this portion of my instrument when used as a measurer of our hearing powers, we have given the name of audiometer.

difference of weight which the instrument at once indicates.

The following experiments will show its exceeding sensitiveness and its wide field of usefulness as an instrument of research.

1. If we introduce into one pair of the induction coils any conducting body, such as silver, copper, iron, &c., there are set up in these bodies electric currents which react both upon the primary and secondary coils, producing extra currents whose force will be proportional to the mass, and to its specific conducting powers. A milligramme of copper on a fine iron wire, finer than the human hair, can be loudly heard and appreciated by direct measurement, and its exact value ascertained. We can thus weigh to an almost infinitesimal degree the mass of the metal under examination; for instance, if we take two English shilling pieces fresh from the Mint, and if they are absolutely identical in form, weight, and material, they will be completely balanced by placing one each in the two separate coils, provided that for these experiments there is an adjustable resting-place in each pair of coils, so that each coil may lie exactly in the centre of the vacant space between the primary and secondary coils. If, however, these shillings are in the slightest degree worn, or have a different temperature, we at once perceive this difference, and if desired, measure it by the sonometer, or, by lifting the supposed heaviest coin at a slight distance from the fixed centre line, the amount of degrees that the heaviest coin is withdrawn will show its relative mass or weight as compared with the lightest. I have thus been able to appreciate the difference caused by simply rubbing the shilling between the fingers, or the difference of temperature by simply breathing near the coils, and in order to reduce this sensibility within reasonable limits, I have only used in the following experiments 100 metres of copper wire to each coil and three cells of battery.

2. The comparative disturbing value of discs of different metals, all of the same size and form of an English shilling, and measured in millimetre degrees, by the sonometer, is the following:—

Silver (chemically pure) ...	125	Iron (chemically pure) ...	45
Gold ,, ,, ...	117	Copper (antimony alloy)	40
Silver (coin)	115	Lead	38
Aluminium	112	Antimony	35
Copper	100	Mercury	30
Zinc	80	Sulphur (iron alloy) ...	20
Bronze	76	Bismuth	10
Tin	74	Zinc (antimony alloy) ...	6
Iron (ordinary)	52	Spongy gold (pure) ...	3
German silver	50	Carbon (gas)	2

These numbers do not agree entirely with any lists of electrical conductivity I have yet met with; the numbers are, however, invariably given by the sonometer, and the divergence may be due to some peculiarity of structure of the metals when formed into disks. Future investigations with this instrument will, no doubt, give more correct values than I have been able to obtain with my limited means of research.

3. It will be seen from the above that the instrument gives very different values for different metals or alloys; consequently, we cannot obtain a balance by employing two disks of different metals, and the instrument is so sensitive to any variation in mass or matter that it instantly detects the difference by clear loud tones on the telephone. If I place two gold sovereigns of equal weight and value, one in each coil, there is complete silence, indicating identity or equality between them. But if one of them is a false sovereign, or even gold of a different alloy, the fact is instantly detected by the electrical balance being disturbed. The instrument thus becomes a rapid and perfect coin detector, and can test any alloy, giving instantly its electrical value. The exceeding sensitiveness of this electrical test I shall demonstrate by experiment this evening. Again, as regards coins, it resolves an almost magical problem. Thus, if a person puts one or several coins into one pair of coils, the amount or nominal value being unknown to myself, I have only to introduce into the opposite coils, different coins successively, as I should weights in a scale, and when perfect balance is announced by the silence, the amount in one box will not only be the same nominal value, but of the same kind of coin.

4. We find by direct experiment with this instrument that the preceding results are due to electric currents, induced by the primary coil, and that it is by the reaction of these that the balance is destroyed, for, if we take an insulated spiral disk or helix of copper wire, with its terminal wires open, there is no disturbance of the balance whatever, notwithstanding that we have introduced a comparatively large amount of copper wire; but on closing the circuit the balance is at once very powerfully disturbed.

If the spiral is a flat one, resembling a disk of metal, and circuit closed, we find that loud tones result when the spiral is placed flat, or when its wire is parallel to those on coils; but if it is held at right angles to these wires no sound whatever is heard, and the balance remains perfect. The same thing occurs with disks of all non-magnetic metals, and a disk of metal placed perpendicular to the coils exerts no influence whatever. The contrary result takes place with a spiral of iron wire or disk of iron, the induced current circulating in the spiral is at its maximum when the spiral lies flat or parallel with the coils, giving no induced current whatever when at right angles, but the disturbances of the induction-balance is more than four-fold when perpendicular to the wires of the coils, than when parallel with the same. That this result is simply due to the property of magnetic bodies of conduction of magnetism, we shall see in some following experiments.

That the currents in non-magnetic metals travel in a circle corresponding to that of the primary coil, may be seen with spongy gold. In its first extremely divided state it falls below our zero of hearing, on slightly shaking the bottle we have 2° as its value; on pressing it its value rapidly increases with the pressure, until when formed into a solid disk its value becomes 117°.

5. The instrument proves that a very remarkable difference exists in bars of iron of the same exact form and size, but of different provenance or treated in a different manner; in point of fact, no two bars, cut off of the same rod, and treated alike, are exactly of the same value, or induce a complete balance.

Mr. Stroh, the eminent instrument-maker, has kindly furnished me with numerous samples, varying in value in degrees of the sonometer from 100 to 160.

Chemically pure iron was found to be the best, but still very slightly superior to ordinary iron, which had been drawn into a wire of the required thickness. The fibrous condition thus developed being highly favourable (if softened by heat) for the conduction of magnetism. From numerous examples I select a few indicative values:—

	Softened.	Tempered.
Chemically pure iron	160	130
Forged soft iron	150	125
Wire-drawn iron	156	120
Cast steel	120	100

6. As yet the instrument has given no indications of molecular change produced by magnetism in non-magnetic bodies, but the great change which takes place in all magnetic bodies, except hard-tempered cast steel, indicates that a molecular change of structure, analogous to that of tempering, takes place upon iron, steel, and nickel.

If we place a disk of iron in one of the coils, we find that the balance is destroyed, and that the iron has weakened the induction by the absorption of work done in inducing

the circular currents. This can be perfectly balanced by placing a small coin or disk of silver or copper in opposite coils; but if an iron wire or rod is placed perpendicular to the coils, then increase of inductive force takes place in those coils by the conduction of induced magnetism from primary to secondary, and the iron can no longer be balanced by silver, copper, or any non-magnetic metal. The coils must be either removed farther apart, so as to reduce the increased force, or balanced by an equivalent amount of iron or magnetic conduction in opposite coils.

An interesting case of both reduction and increase of force in the same pair of coils occurs if we place a disk of iron, not in the centre of coils, but in the vacant space between the coils. We thus reduce the force by 150°. If, in addition to this, we place iron wires perpendicular and in the centre, there is increase of force, and if this increase is so proportioned as to be 150°, we immediately restore the balance, and we have here in the same coil two separate pieces of iron, each disturbing the balance and giving out loud tones, but producing no effect whatever, when both are introduced at the same time, complete silence being the result.

7. These coils prove what has already been long known, viz., that hard steel has a far less conducting power for magnetism than soft iron, although the hard steel has a far higher retaining power. This instrument demonstrates a point, which I have not yet seen remarked, that magnetism does not in itself change the conducting powers, but that it produces a molecular change of structure in iron, analogous to that of tempering; for if we balance two soft iron rods against each other, the balance being made perfect by the addition of fine iron wires on the weakest side, we find that on strongly magnetising this bar, by drawing it across a strong compound magnet, and on replacing it in its coil, it has lost 30 per cent. of its conducting power; or if, instead of magnetising we make this iron red hot and plunge it in cold water, the loss of conducting power will be very similar—25° to 30°. If these experiments are repeated upon various degrees of iron approaching steel in character, we find that as it already possesses hardness or temper, it is less and less affected by magnetism, until we arrive at hard cast steel, where magnetism no longer produces any change in its conducting powers. From this I draw the conclusion that the effect of magnetism is very similar to that of temper, and shall show under the effects of strain and torsion that magnetism produces this temper or strain perpendicular to the lines of magnetic force.

8. The instrument shows that a remarkable change takes place in the magnetic conducting power of iron and steel on subjecting the wire under examination to a longitudinal strain; for if we pass an iron wire through the centre of both coils, half a millimetre diameter and 20 centimetres or more in length, so arranged by a winding key that we can apply a strain to this wire, we find a magnetic conducting value, unstrained, of 100, but on applying a slight strain its value rapidly increases, being more than double at its breaking point. If during this strain we strike the wire, we hear its musical tone, and no matter how much we may wind or unwind it, provided we do not pass its limits of elasticity and similar wire is used, that the same musical tone will invariably give the same magnetic value. Thus the note A, or 435 complete vibrations per second, gave always the magnetic value of 160, or 60 per cent. increase of power over the unstrained wire. If whilst this wire is strained, giving the value 160, we magnetise it by drawing over it a strong compound magnet, the note remains the same, showing no difference of tension, but its magnetic value has fallen 80°, being now 80 instead of 160; and this wire can never again be brought by strain up to its previous high conducting powers. Now as we have seen that magnetism produces no change in hard tempered steel, but that it does so in soft iron very analogous to that of temper, and as the effect of strain would be also to harden the fibres by bringing them all parallel to the line of mechanical strain; and as this improves its conducting power, while magnetism instantly destroys all the benefits of the longitudinal mechanical strain, we can only draw the conclusion that magnetism produces a strain analogous to temper, but contrary to that of the longitudinal mechanical strain; in other words, that the magnetic strain is produced perpendicularly to its lines of force.

This view is sustained by the effects of torsion; for if, in place of straining the wire, it is twisted, instead of increasing, it rapidly decreases in magnetic conductive value, each turn or twist decreasing its power of conduction in a remarkable constant line of decrease. At eighty turns of this wire there was a decrease of 65 per cent.; at eighty-five turns the wire broke, and on testing it to see if magnetism had any decreasing effect on it, I found that it produced no change whatever; but this twisted soft iron wire had now remarkable permanent retaining powers of magnetism, being superior to tempered cast steel.

Again, if we take three similar pieces of soft iron wire, leave the first for comparison in its natural condition, strain the second by a longitudinal strain until it is broken, and twist the third by a torsion-key until it also is broken; we find on magnetising equally these three wires, and allowing ten minutes' repose, that the first or untouched wire has a retaining power of magnetism of 100, the second only of 80, and the third, or twisted wire, of 300. I hope by the light thus given soon to be able to produce a magnet whose force shall be greatly in excess of what we have hitherto possessed, our difficulty at present being that in order to temper steel we must heat it to redness, and this allows the molecules to rearrange themselves contrary to the object we have in view.

9. There is a marked difference of the rapidity of action between all metals, silver having an intense rapidity of action. The induced currents from hard steel or from iron strongly magnetised are much more rapid than those from pure soft iron; the tones are at once recognised, the iron giving out a dull, heavy, smothered tone, whilst hard steel has tones exceedingly sharp. If we desire to balance iron we can only balance it by a solid mass equal to the iron to be balanced. No amount of fine wires of iron can balance this mass, as the time of discharge of these wires is much quicker than that of a larger mass of iron. Hard steel, however, can be easily balanced, not only by steel but by fine iron wires, and the degree of the fineness of these wires required to produce a balance gives a very fair estimate of the proportionate time of discharge. The rapidity of discharge has no direct relation with its electrical conductivity, for copper is much slower than zinc, and they are both superior to iron.

10. The instrument shows a marked difference in all metals, if subjected to different temperatures. The value is reduced in non-magnetic metals, and this we should expect from the known influence of temperature on the electrical conductivity; but in the case of iron, steel, and nickel (as it has already been remarked by many), the contrary takes place, namely, a far higher degree of magnetic conductivity. A bar of soft iron, whose value at the temperature of the room, 20° C., was 160, became on heating it to 200° C., 300, that is to say, its value was nearly doubled. A bar of pure nickel, whose value at 20° was 150, became on heating it to 200°, 320; thus, in the case of nickel, its value for magnetic conductivity was more than doubled, and at this heat it surpassed the chemically pure iron at the same heat, giving a magnetic value of 320 against 300 for the iron, but at the normal temperature of 20° the iron had more magnetic power of conduction than nickel. Heating nickel by simply plunging it into boiling water increased its force from 150

to 250, plunging this same bar into ordinary cold water reduced its value to 130; thus the mere difference of the normal temperature of the air in the room and water which had been in this room some hours produced 20° of difference. In fact, I found that the radiant heat from the hand would raise the magnetic value several degrees, and thus nickel may be regarded as a magnetic thermometer far more sensitive than the ordinary mercurial centigrade.

The instrument also measures the electrical resistance of wires or fluids. In order to make it do this we have only to place the resistance to be measured across the two wires of one induction-coil and on the other known resistance units. In this way we can produce a perfect balance, for it then becomes an induction bridge, the results and modes of testing of which are somewhat similar to Wheatstone's bridge.

It measures also the electrostatic capacity of Leyden jars or condensers, and is sufficiently sensitive to appreciate and measure a surface of tinfoil not larger than four inches square, the condenser being simply placed between the wires of one pair of coils, and the disturbance produced being measured on the sonometer.

I could cite many more interesting experiments in other branches of physical research for which this instrument offers a wide field of observation; but my object this evening is neither to broach new theories nor to correlate at present the results obtained with views already advanced by Ampère and others.

My only desire has been and is to show the wide field of research the instrument opens to physical inquirers. I trust that in more able hands it may serve to elucidate many physical phenomena.

ON THE EVOLUTION OF THE VERTEBRATA[1]

III.

CROCODILIA.—The crocodiles form another group of reptiles which has become isolated from all the contemporary groups or orders. The most perfect antithesis of the bird, the crocodile, is, nevertheless, in essentials, in strict conformity with the bird pattern; or, rather, both it and the bird conform to the pattern of some ideal or vanished reptile.

This likeness can be shown in the body, but it is most evident in the head; although unlike the bird's skull in general specialisation, that of the crocodile is, in all essential respects and in numberless details, like that of a young bird. Compare the strong, solid, and dense skull of the crocodile, with its thick, pitted, and rugose bones, and accurate and dentated sutures, with that of a parrot, a toucan, or a hornbill—scarcely a suture left, the bone looking like polished ivory and the substance so completely spongy within that its weight is but little more than that of a few quills of the same bird. Yet these lightest and most delicate of all skulls had once all the sutures seen in that of the crocodile, and the two types of skull developed each "centre" in the same manner and on a similar model; in the middle of the incubating period they were so much alike that one diagram might have served to illustrate both.

In their covering, as well as in their general form, the crocodiles contrast strongly with the birds; instead of a soft plumage, often gorgeous in colour, they are invested with a coarse armour of segmental rows of rough plates of bone (dermostoses), coated over with horn. Representatives of the turtle's plastron are seen in the so-called abdominal ribs—which must not be confounded with like structures of the same name seen in the chamæleon and *Hatteria*—and in the inter-clavicle, which is fixed to the under-surface of the breast-bone.

The frame-work of the body is well ossified in the adult, and the vertebræ and ribs are very similar to those of a bird, the greatest difference being in the neck, which is much shorter and stouter, and has much larger rudimentary ribs, which remain permanently distinct. In the young of the *Ratitæ* (Emeu, &c.), however, all the cervical vertebræ except the atlas and axis, have a pair of ribs, which remain distinct for a considerable time in the upper part and permanently in the lower part. The crocodile's sacrum also, instead of being composed of a large number of joints, has merely two, that carry the pelvis, whilst the tail, instead of being arrested, as in living birds, is developed, as in the ancient *Archæopteryx*. The vertebræ of the crocodile are for the most part *procœlous* (concave in front and convex behind), and thus resemble those of the dorsal region of plovers, penguins, and some other water-birds. The setting in of the ribs and their overlapping (*uncinate*) processes are also similar to what is seen in birds.

The rhomboidal sternum is cartilaginous, and sends out behind a pair of *xiphoid* processes, being defended in front by the bony interclavicle, which is the counterpart of the leg of the Y-shaped merrythought of the fowl. The shoulder-girdle is composed of a pair of cartilages with a gentle curve and of a moderate width; each is ossified by two bones, an upper, the *scapula*, and a lower, the *coracoid*.

In the head, all distinction between dermal scutes and sub-cutaneous bones is lost; a thick web is ossified throughout, and has only left a thin layer of the skin soft, as a "quick" to the horny coat. From the snout to the exit of the optic nerves, the internal cranium is unossified, while the posterior part is well ossified, as are also the basal region up to the pituitary body, the capsules of the ear, and the alisphenoids. The labyrinth of the nose is very simple. A hard palate is formed by the maxillaires, palatines, and pterygoids, thus causing the nasal passages to open far back in the throat, this specialisation being of advantage to the crocodile while drowning his prey.

The structure of the organ of hearing agrees with that of the tortoises and the higher lizards, the drum cavity being formed inside the quadrate, into which an air-tube (*siphonium*) opens into the mandible, as in birds. The two drum cavities communicate in a passage running over the skull behind. A rudiment of this passage exists in birds, and in the higher kinds opens into the spongy tissue which lies between the two tables of the skull.

Birds.—The lower tentative forms of birds have for the most part evidently come and gone during the time the crocodiles have been in existence. The palæontologists, however, are beginning to show us how thoroughly intermediate between the true reptiles and birds the extinct birds of the chalk and the oolite were. The most ancient or generalised types of living birds, the ostrich tribe, are all incapable of flight, but the oldest bird known in the fossil state—*Archæopteryx*—was well fitted for flight.

Interesting connecting links between the ostrich tribe and the higher forms are seen in the southern world (*Notogœa*), where many of the birds have a much lower and more reptilian structure than their northern relatives, their power of flight being less, their brain smaller, and in many cases they are deficient in the inferior larynx or *syrinx*. Thus the South American *Tinamous*, which are intermediate between the ostrich tribe and the grouse, have a very small brain, and consequently such low intelligence that they have not the sense to use their own wings; moreover, their flesh resembles that of a reptile, they possess lacertilian super-orbital bones, and a considerable number of the sutures in the head remain permanently open. These birds do not so much resemble the South American Rhea as the Australian *Apteryx*, representative species being often found in these two regions which correspond with each other, but are far more ancient than, and do not correspond with, the types found north of "Wallace's Line."

[1] Abstract of Prof. Parker's Hunterian Lectures, delivered at the College of Surgeons, commencing on February 10.] Continued from p. 64.

The influence of desert or prairie life has doubtless had much to do with the modifications found in the ostrich tribe; the principal of these modifications are, the abortion of the tail, the lessening of the wing, the huge increase in the size of the hind-limbs, and the suppression of unnecessary toes.

It is quite within the bounds of reasonable conjecture to suppose that from time to time great waves of morphological force, so to speak, and fresh revivals of life, passed over the old reptilian fauna, and that many kinds of the more ductile reptiles yielded to the influence of these waves. When, however, one member improved, the other members improved with it; the loss of digits and their claws, the sport that appeared in the exchange of feathers for scales, the increased solidity of the sacral region, and the tighter setting on of the hind limbs—these were only a few of the things that were correlated in this radical reform of the old reptilian types. The teeth were only slowly lost, as the invaluable papers of Prof. Marsh show. Epidermal imitations of teeth, however, occur in existing ducks and geese, and in the South American Passerine, *Phytotoma rara*, in which latter they are ossified from the jaw.

The hot condition of the bird's blood has much to do with the intensity and rapidity of its early metamorphosis. The time in which arboreal birds (*Altrices*) are ripened for hatching is marvellously short, and after this, in a single month, many of them have learnt their lesson in flying, and begin to be ready to migrate.

The segmented form of the simpler fish, or amphibian, is still to be traced in the bird. The embryo of the swan develops six dozen segments behind the head, twenty-five of which belong to the neck. Most of these segments can be traced in the adult, except those of the tail, the posterior ten of which, though separate at the time of hatching, grow together to form the plough-share bone, on which the tail-quills are set.

The endo-skeleton is greatly developed, and its ossification is carried to the utmost degree of perfection, only traces of cartilage persisting in the joints and often in the nose.

The outer skeleton may be divided into three categories. The first of these consists of the exuberant and unique growths of the epidermis—the feathers and quills, to which must be added the horny sheaths of the beak and the scaly coverings of the legs. The second consists of the overlapping series of cartilages that become ossified to form the limb-girdles from which the limbs grow out, and also a pair of sub-cutaneous cartilages in front of the head, which belong to the labial category, and sometimes there is one on each ramus of the mandible. The third takes in the sub-cutaneous bones that invest the proper endo-skeleton, whether bony or cartilaginous, and the ossified tendons and fasciæ (*aponeuroses*). There are three proper investing bones, as a rule, attached to the shoulder-girdle, which coalesce to form the greater part of the merrythought (*furcula*); these, as before mentioned, are the counterparts of the ventral splint-bones of Plesiosaurus and Hatteria, and their non-coalesced representatives are also seen in lizards and in the Monotremes. In the head there is a large number of investing bones, which, however, enjoy for the most part a very temporary independent existence.

The increased size of the brain-mass has given rise to a very different proportion of cranial to facial elements as compared with what exists in the reptile, and the process of ossification is carried to its utmost perfection. Except at the articular extremities of the bones, all the original cartilage rapidly disappears; this matrix is succeeded by marrow, which is in many cases completely absorbed, giving rise to air-cavities, which open into the nearest air-sac.

The endo-skeletal palatine bones are ossified to a great extent whilst the tissue is still formed of young and soft cells, before the solid hyaline cartilage has had time to grow, and in many passerine birds the exo-skeletal vomers are grafted upon a pair of cartilages, which, however, also belong to the outer skeleton. No true cartilage has yet been found in the outer ear. Rudiments of the hyoid and first branchial arch exist behind the lower jaw.

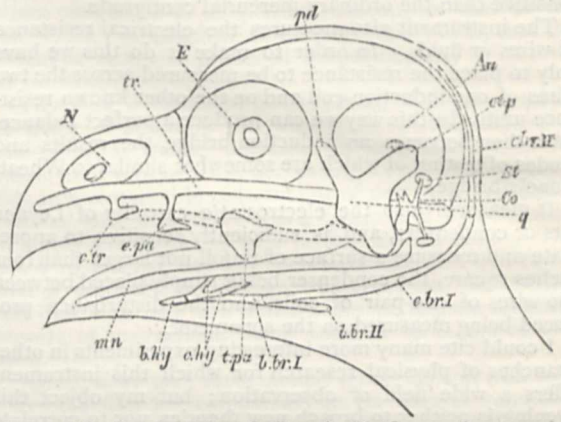


Diagram of the Chondrocranium of a Passerine Bird. *au*, auditory capsule; *b.br*, basi-branchial; *b.hy*, basi-hyal; *c.hy*, cerato-hyal; *c.br*, cerato-branchial; *co*, columella; *c.tr*, cornua trabeculæ; E, eye; *e.br*, epi-branchial; *e.pa*, ethmo-palatine; *mn*, mandible; N, nasal capsule; *ot.p*, otic process; *q*, quadrate; *st*, stapes; *t.pa*, trans-palatine; *tr*, trabeculæ

The protrusible and retractile face of the bony fishes is constructed in a manner very similar to that seen in the hinged fore-face of a fowl or parrot; in these birds, as in the fishes, the pre-maxillaries push the maxillaries aside, cover them over, and keep them from the dentary edge, thus converting the bones usually so massive, into feeble "moustache bones" (*ossa mystacea*, Cuvier).

Mammals.—Such a hypothesis as that Nature bred either all her birds or all her mammals from one stock is at once upset by the facts presented by the structure of the lowest mammals—the duck-billed platypus and the echidna. Between the mammals and the types which foreshadow them, viz., the Selachians and the Batrachians, there is unfortunately a large chasm; and moreover, the platypus and echidna refuse to lie fairly in the direction indicated at the top of this chasm, as they confusingly partake of the characters of the reptile and bird; as well as those which are peculiarly mammalian.

The skeletal parts of the mammal are modified in a great number of ways answering to the great variety of their modes of life, and especially in regard to prehension and progression. In the higher kinds there are few or no subcutaneous bones (*parostoses*) in the body, but the head depends upon these for its construction as much as in the birds: where there are no clavicles there are no parastoses behind the head.

In the lowest forms (platypus and echidna) there are three clavicular bones; in the pangolin (one of the *Edentata*) the body is covered with large imbricated scales; the armadillos have strong body armour, which is both bony and horny, as in the tortoises and crocodiles, and in certain rodents, such as the South American *Cœlogenys* and *Lophiomys imhausii*, the bones of the head resemble very much the bony scutes of the lower types, for they become granular and almost ganoid on their outer surface. The endoskeleton and the overlying limb-girdles and limbs are developed to a perfection peculiar to the mammal, the culmination of which is seen in our own species.

Above the lowest forms, neither in the low marsupials nor in the almost equally low Edentata, do we find the middle collar-bone (inter-clavicle). Moreover, in the large Herbivora with a keeled chest, the paired clavicles also disappear; in man, monkeys, bats, moles, and shrews,

they have their largest development, but do not correspond merely to the paired bones of the lizard and platypus, being formed both of cartilage and bone as in the bird. The girdle of the hind-limb is of a more archaic and less metamorphosed pattern than that of the fore-limb; in man the pelvis corresponds very closely with the shoulder-girdle of the frog. The limbs agree nearly with the tailed amphibian pattern. The main modification of the spine is seen in the presence of inter-central pads or buffers of cartilage, and a pair of bony *epiphyses* to each centrum.

The skull is wrought into one strong, compact building, and the short, solid, lower jaw is articulated directly to the head; the *primary* lower jaw stops growing at a very early period of embryonic life, and then loses, by absorption, the Meckelian rod, which is, indeed, all the arch except its upper part; the working mandible is formed from superficial bone and cartilage, the prototypes of which must be sought amongst the lowest fishes. The upper part of the primary mandibular arch, which in the lower types gives rise to the quadrate, is now specialised to form the *malleus*, or the outermost bone of the chain of the middle ear. One principal external bone and sometimes an imperfect rudiment of one or two others appears on the inside of the primary lower jaw in the embryo, but these enjoy a very short separate existence. In the hyoid arch the upper element, or epi-hyal, is divided off to form the *incus*, the middle bone of the middle ear. The *orbiculare* is a further subdivision of the upper element, and the stapes is a part of the auditory capsule segmented off. The cochlea, which, in the Sauropsida, forms only part of a coil, is now perfected into a spiral chamber with several turns. The membrane of the drum lies at the bottom of a long tube, and is there stretched upon a bone which at first is a mere imperfect ring, but which afterwards grows out as the bony *meatus externus*. The *concha auris* is an opercular cartilage of the first cleft, the essential part of which is the *tragus*.

Outside the primary lower jaw, the two halves of which are confluent in front and below, there is a cartilage having the same relations as the *labial* of a shark; in the outside of this cartilage the *dentary* splint bone appears, and gradually converts it into bone, from before backwards. Throughout life part of this cartilage still remains, capping the convex hinge of the lower jaw; it is probable that the cartilaginous plate within the joint (*meniscus*) and the cartilage lining the temporal bone above, to finish the joint, are derived from the same source.

As already mentioned, the forecast of the mammalian type, which is very plain in the cartilaginous fishes, becomes much more plain, definite, and indubitable in the frog and toad. In fact, the building materials are passed from hand to hand, as it were, in this way: the batrachian forefathers brought down all things meet for the work, borrowing and taking cartilages from the Selachians, and bones from the Ganoids, and noiselessly forming them, after due selection, into a new, more compounded, and nobler structure.

The rude ancestors of the tribes that give suck began to build on this higher level, with these more varied or better-shaped blocks and plates; and by the infinite cunning, the effectual working of the morphological force, in due time the consummation was effected of vertebrate form. But the consummation of all, the election and selection, that has been going on since the beginning of the ages, is seen in man, who alone gives meaning to, and reads the meaning of, the whole mystery of organic life.

OUR ASTRONOMICAL COLUMN

THE OBSERVATORY OF MANNHEIM.—We have received from Prof. Valentiner, the successor of Prof. Schönfeld in the direction of the observatory at Mannheim, the third part of the "Astronomical Observations" issued from this establishment. The two former parts, published in 1862 and 1875, contained observations of nebulæ and clusters, but without micrometrical measures of the positions of the components of the latter objects; in the present part the two clusters Nos. 1166 and 4410 of Sir John Herschel's General Catalogue are specially treated upon, and the position of thirty-six stars in the former cluster and seventy-one stars in the latter have been determined by micrometrical reference to a number of stars the places of which have been fixed by meridian observations. In this work a filar-micrometer upon the Steinheil refractor has been employed, and both observations and reductions have been made with every care to secure a high degree of precision. Diagrams of the stars observed in each cluster are appended. It is intended to measure the clusters 1454 and 1119 of the General Catalogue in the same manner. Only by patient and accurate measures of this nature can we hope eventually to learn the internal structure of these systems. Prof. Valentiner has given full details of his observations and reductions, which may be advantageously consulted by any one proposing to enter upon similar work. The Mannheim Observatory not possessing a meridian-circle, he has had recourse to the assistance of other observatories—Berlin, Leyden, and Leipsic—for the accurate determination of the positions of his reference-stars.

TEMPEL'S COMET.—M. Raoul Gautier has circulated an ephemeris of this comet, founded upon a correction of his predicted elements from three observations by Dr. Tempel at Arcetri. The positions for May do not materially differ from those which have appeared in NATURE. The corrected orbit is as follows:—

Perihelion passage 1879 May 7·02 M.T. at Berlin.

Longitude of perihelion	238 11 30·1	From mean equinox 1879·0
,, ascending node	78 45 37·4	
Inclination	9 46 31·6	
Angle of excentricity	27 35 0·6	
Mean daily motion	593″·18	
Log. semi-axis major	0·517880	

THE MINOR PLANETS.—From the *Berliner Astronomisches Jahrbuch* for 1881, which is just published, it appears that of the 194 small planets discovered up to the end of March last, eighteen have been observed at only one opposition, one of the number being *Medusa*, which, if the elements so far determined can be relied upon, has a shorter period of revolution than any other member of the group, *Flora* coming next. Upwards of 150 pages are devoted to the elements and ephemerides of these bodies for 1879, forming the speciality of this publication, upwards of forty calculators in various parts of Europe and America taking part in this laborious work; seventy-one of the ephemerides are by Dr. Maywald, of Berlin, who has been long similarly occupied. As already stated this portion of the *Berliner Jahrbuch* has been sent out to observers in anticipation of the appearance of the volume. The circulars independently issued by Prof. Tietjen have kept astronomers informed as to elements and positions of the newly-discovered bodies.

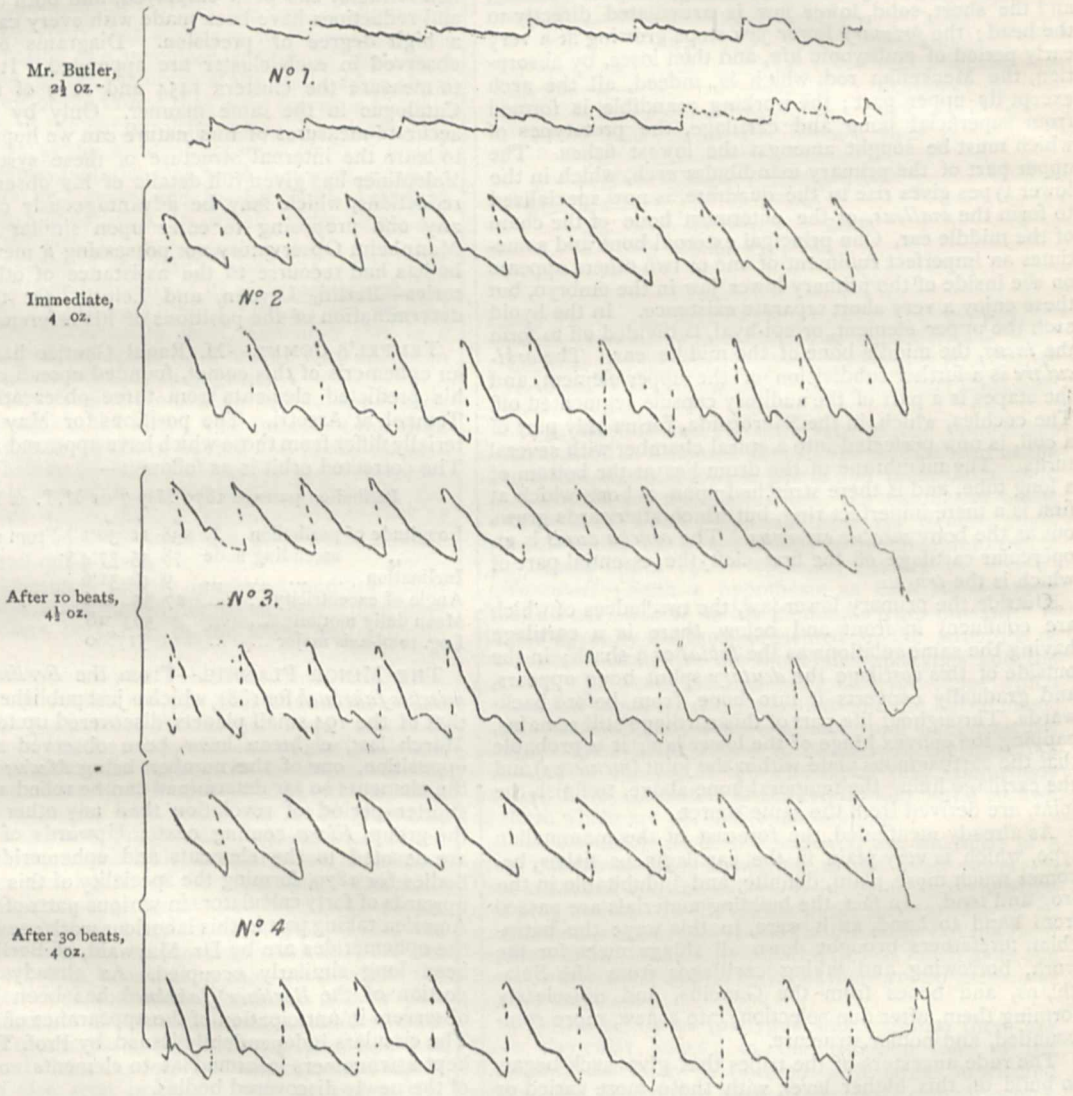
Prof. Peters, of Clinton, New York, announces his detection of a planet which, if new, will be No. 196.

THE OCCULTATION OF VENUS ON AUGUST 20.—On this date Venus, then at her greatest brilliancy, and so of crescent-form, will be occulted by the moon, which is also a narrow crescent at the time. The phenomenon would be one of much interest were it not that it is visible in a dark sky, only in the South Atlantic. If we calculate for the Royal Observatory, Cape of Good Hope, we find that the immersion takes place at 8h. 44m. mean time, but the planet will have set about five minutes previously, and in other parts of the South African Colonies, the occultation is similarly invisible. At St. Helena there will be no occultation.

A SPHYGMOGRAPHIC EXPERIMENT

AN experiment which I have recently been enabled to make by means of the sphygmograph may perhaps be of sufficient interest to deserve a brief record in your columns.

It occurred to me while preparing for the Croonian lectures, which I had the honour of delivering before the College of Physicians a few weeks back, that some light might be thrown on the movement of the blood in the vascular system, if an ordinary tracing of the healthy radial pulse, a series of tracings was made to ascertain the pressure which produced the most characteristic curve-line. This proved in Mr. Butler's case to be two and a half, in that of the porter, four or four and a half ounces. This adjustment having been obtained, a normal tracing was taken on a broad slip of smoked plate glass at its lower portion. The three gentlemen above-named were instructed to compress simultaneously the two femoral arteries and the right axillary. A second tracing was then taken on the upper half of the same slip, so that it could be accurately compared with that already taken. Mr. Butler's pulse, even after it had been excited by the administration of a full dose of whisky (about three ounces), was too quiet and undemonstrative to give very striking results, though it will be seen that the excursion is diminished, the rate is rendered perceptibly slower in the ratio of six to seven, and the distinctive aortic notch is obscured by a number of smaller undulations. In the case of the porter we had to deal with an older man, of very muscular build, with a strong bounding, though not morbid pulse, who has been for some years in a Guards regiment. The first pair of tracings (No. 2) here showed a very important modification in the contour of the undulation. To eliminate any error due to a pulse were compared with one taken under different circumstances, wherein a large portion of the arterio-capillary network was thrown out of the circuit. By the kind assistance of my colleagues, Dr. Sharkey, Mr. Pitts, and Mr. Sandwith, I was able to put this hypothesis to the test, the result being the four pairs of tracings accompanying this communication. The patient in the first case (No. 1) was Mr. Butler, a pupil of the St. Thomas's Hospital, and in the last three instances one of the porters in this institution. The *modus operandi* was very simple. The sphygmograph having been firmly applied to the left



In all the tracings the lower is the normal pulse, the upper one with vessels compressed. Nos. 2, 3, 4, from the same patient, George Watts, æt 37.

merely transitory change, ten full pulsations were in the second case (No. 3) allowed to elapse after the complete closure of the three large vessels above-named, before the second tracing was taken, and in the third trial (No. 4) thirty beats were steadily counted with the vessels occluded, before the second tracing was obtained. Beyond this I did not feel justified in going, for fear of phlebitic or thrombotic accidents. It will be seen, however, that the change of character in the wave becomes decidedly more marked in each succeeding instance than in that preceding it. It consists roughly in the total obliteration of the dicrotic wave termed the "aortic notch." Accompanying this is an increase of rapidity and suddenness in the line of ascent, which, from being nearly vertical in the uncompressed, bends distinctly backwards in the compressed tracings, thus reproducing the circular arc in which the index of the sphygmograph travels. The latter fact might have been anticipated, but the former is curious, and I believe novel. The compressed tracings might be mistaken by an observer not acquainted with their mode of production, for those of a patient in whom the competency of the aortic valves was gravely impaired, and where the reflux of blood into the ventricle, which, in a healthy condition is prevented by their sudden closure, was freely taking place. On the plausible supposition that the dicrotic wave is a return undulation, a sort of echo sent back from the distal extremity of the arterial tree, it may be suggested that the great shortening thus artificially produced in the wave-length of the fluid undulation causes the primary and dicrotic waves to merge into one another.

I may say that neither of my patients felt any inconvenience from the experiment, either during compression or afterwards. An attempt was made to cut the internal iliacs also out of circuit by compressing the abdominal aorta before its bifurcation; but though to a good anatomist like Mr. Pitts the occlusion of this large vessel was not difficult, it caused so much hiccup and respiratory spasm as to render the continuity of the tracing uncertain.

W. H. STONE

THE ELECTRIC LIGHT

WE have already referred to the Albert Hall Exhibition, and its important bearing on the progress of electric lighting by bringing together the various methods by which it has been proposed to utilise electricity for this purpose. Since then the newspapers have brought us intimations of further progress which it is stated Mr. Edison has made, and as our readers doubtless know, he has taken out one or more patents for various alleged improvements. We have borne, and will continue to bear, willing testimony to the marvellous ingenuity of Mr. Edison in his application of various scientific principles, resulting in inventions that a year or two ago were scarcely dreamt of. We cannot but have the sincerest wish for Mr. Edison's success in whatever he puts his hand to; and his position as an inventor is so high that he needs not to take any trouble to make it more exalted by allowing exaggerated and misleading statements to go forth as to what he is about to do.

We have recently heard a great deal of Mr. Edison's experiments and promises with reference to the electric light. He startled the world in August last by announcing a great discovery which was to revolutionise the modes of artificial illumination at present in use, but we fear his discovery turned out to be something very like a *ridiculus mus*. Two of his patents have been published; one contains what we must deem a grave scientific error, the other the best authorities consider a mere reproduction of things that have been patented before by Staite, Harrison and others. Up to the present, so far as we can make out, he has done nothing new nor has he produced anything practical. The reports of newspaper interviewers are scarcely worthy of attention. Mr. Edison himself complains bitterly of their importunity and irrepressibility; but why, then, does he seem to stamp them with his approval by distributing their reports from his own laboratory? We cannot but think it a misfortune that he has kept at arms' length the electricians of New York, not one of whom, according to his own statement, has been allowed to enter his laboratory. We are therefore entirely dependent upon the New York press for our knowledge of his progress.

He has laid aside for the present his incandescent light and is experimenting with the Wallace form—his reason being that "everybody knows what the carbon lamp is, and besides it is not my lamp." He is engaged upon a new dynamo-machine—let us hope not his tuning-fork arrangement—but for what reasons he has put aside such perfect machines as the Siemens and the Gramme we are not enlightened. Dr. Hopkinson has recently shown that the Siemens' machine utilises 90 per cent. of the energy thrown into it. The Gramme is not far behind this. Mr. Edison can scarcely hope to improve on either. Again, the Brush and Wallace-Farmer machines are very efficient. Indeed, we scarcely want to improve the machine for producing currents. It is the lamp that needs the thought and work of the inventor, for no lamp yet exists worthy of the name.

The propagation by the daily press of scientific "discoveries" hot from the brain before they are allowed to be cooled down by the test of experiment is an invention upon which we cannot compliment our American friends. It does not conduce to the progress of science nor does it redound to the credit of the discoverer. We are accustomed on this side of the water to learn of new discoveries through the medium of well prepared and carefully digested papers submitted to one of our societies. There are such societies in America, but the records of such societies have to be searched in vain for any experiments or discoveries of Mr. Edison. We think it is matter for sincere regret that he prefers to promulgate what he conceives to be new through "our special correspondent," and the science dished up by these gentlemen is something wonderful to read. Thus says one paper:—

"Being questioned as to the subdivision of the electric light, the inventor said: 'The question is very simple. If you take a lamp in which the voltaic arc is produced from two carbon pencils, the more current you put on the faster the pencils are consumed and the resistance offered is lessened. There necessarily results a great waste of power. If the lamp is limited to 250-candle-light, it costs too much. By my plan the resistance is almost entirely at the lamp. The resistance of the conductor is to the resistance of the lamp as 1 to 100. The resistance of my lamp is as 192 against 1 to the resistance of the carbon lamp. You may consider the question most intelligently by taking a gas-burner as an example. If you have a half-inch gas-pipe and light the escaping gas without putting on a burner, how much gas-light can you get from an adjoining burner? Very little. But if you put in the half-inch pipe a burner, with a pin-hole in it, you get a light without interfering with other burners. The same condition obtains in electric lighting. The carbon lamp represents the half-inch gas-pipe; the pin-hole burner represents my lamp.' 'But is not the electric current exhausted, not with regard to the resisting agent, but according to the square of the distance travelled?' 'No. If you are supplying a mile of wire and then add another mile, the current will be weakened equally throughout the whole line, but not to that extent. If you keep on extending your line, you will have to make your conductor thick and add more power.' 'How do you propose to carry this theory into effect?' 'I shall have, proceeding from the central station, where a steam-engine and a series of dynamo-machines are placed, a

cable, say about an inch in diameter, composed of copper wires, each about one-sixteenth of an inch in diameter. The cable will be laid in a trench immediately under the flagging of the side walk, and near the curb; every twenty-five feet a wire will be dropped to carry the current into a house, and when the terminus of the cable is reached there will be one wire left. Of course it will be necessary to construct the cable according to the number of houses in each district. As a district increases in population the flagging can be taken up, and a section of cable can be placed alongside the original cable, and joined to it at each end. Thus the new houses can be supplied.' 'Will there not be a loss of electricity by induction or the influence of the earth?' 'None whatever. And now I will tell you another thing. It is perfectly easy for me to get a light equal to sixty-six candles from each of my lamps: but I limit them to six.' 'Will not the construction of your station and your cables be very costly?' 'No; and if it were, the profits would warrant the outlay.'"

Copper wires one-sixteenth of an inch in diameter—the same size as those often used for telegraphic purposes—are to convey currents of electricity to light up lamps whose resistances are as 192 to 1 as compared with carbon, or as 100 to 1 as compared with the conductor. The resistance of the copper wire is about 13 ohms per mile. What current will be required to produce a light of 66 candles a mile off under such conditions? An electromotive force of a 1,000 volts would not do it, and the very best machines do not much exceed 100 volts in this respect. Where is the power to come from? Mr. Edison now proposes to have 30 of his new dynamo machines worked by his 80-horse-power steam-engine, lighting up 400 lights. In other words, each machine is to produce about 13 lights, and to absorb $2\frac{2}{3}$ horse-power. This shows that his experience is gradually bringing him down to the limits of our experience in France and England, where for some time past one machine lights up twenty lights, but with an expenditure of 23-horse power. It also shows that he was premature in announcing the solution of the indefinite subdivision of the light, and that he would have done well to have worked upon the experience of others rather than have learnt that experience himself by an immense expenditure of time and money. The electric light, theoretically and practically, is unquestionably more advanced in Europe than it is in America. But even here the progress in lamps is very slight.

Col. Bolton, in a remarkable paper read at the last meeting of the Society of Telegraph Engineers, has shown that electric light manias are not only periodic, but that the very same inventions are to a certain extent, also periodic. Thus he showed that everything that Mr. Edison has patented has been patented before in England.

NOTE AS TO DISTINGUISHING CHARACTERISTICS FOR ILLUMINATED BUOYS

THE plan of illuminating by means of Pintsch's system of forcing gas into floating buoys having now been tried by the Trinity House and by the Harbour Authorities of the Tay, I have lately been engaged in considering the best means of distinguishing one buoy from another.

The plan which occurred to me was *to make the flow of the gas produce automatic intermittent action*, and for this purpose some form of gas meter seemed to promise best. I applied to Messrs. Milne, gas engineers, Edinburgh, to give me their assistance in the matter, and they have succeeded in making a modification of a dry meter which has been tried and found to work very satisfactorily. By this arrangement a small supply of gas keeps a small jet constantly illuminated a little above the principal burner, and when, by the valve, the full supply of gas is turned on to the large burner, it is ignited by the small jet. The periods of light and darkness can be regulated in any desired proportion. The same object may, however, be effected by means of a single burner, the jet being kept burning in the socket.

By means, then, of two separate lanterns, one of which has red panes, and the other either white or green, the following characteristics may be produced:—

Red and white.
Red and green.
Green and white.

If, again, only one lantern be used, we shall have—

Intermittent white.
" red.
" green.

And if to these we add the present single fixed white, red, and green, this would give in all nine characteristics, which would probably be sufficient for any navigation.

It is proper to add that, in order to prevent oscillations of the apparatus, which would take the light out of the sailor's vision, the apparatus and burner should be made to work in gimbals, as in my steamer's lights. If these gimbals were made hollow, the gas could be easily made to pass up to the burner, but a simpler mode would be to use a flexible tube between the regulator and the burner.

THOMAS STEVENSON

GEOGRAPHICAL NOTES

LETTERS from Nordenskjöld have been received by the Governor-General of Siberia. They confirm the news already brought to Europe. The *Vega* steamship has been blocked by ice in a harbour named Kamen, at a short distance from Behring Straits on the east coast of Siberia. This station is easily reached by whalers every year. No doubt the escape of the explorer and his companions will take place without difficulty as soon as the ice breaks up, probably in a few weeks. The news has been brought by native messengers, and everything was going on well on board the *Vega*.

M. WOEIKOF has sent to the French Geographical Society a long and exhaustive memoir on the Oxus question. After having studied the question on the spot, the Russian geographer feels certain that the suppression of the Caspian mouth was produced not by a gradual elevation of the country, but by the accumulation of deposits in the bed of the river, and the immense drainage produced by the development of irrigation in the Khivan Oasis. He feels certain that the restoration of the former state of things would be a very easy work. It would result in the establishment of a new oasis between Khiva and the Caspian Sea. The Oxus being navigable to Balkh, and the Volga being in direct communication with the Baltic, through a system of canals, a water-way would thus be established from St. Petersburg to Balkh, and the stream would connect the Russian capital with the vicinity of their scientific frontier of India. M. Woeikof supposes justly that the restoration of the Oxus to the Caspian would accelerate the retreat of the Aral waters. He believes that shortly after that large operation the area of Aral would be reduced to one-third of its present extent. But he argues that this alteration would not be altogether detrimental to the prosperity of the surrounding countries.

THOUGH there are no journeys of discovery into the interior to record, some useful geographical and topographical work was done in Western Australia by the Surveyor-General's department during the last six months of 1878, as we learn by a report just received from Perth. The position of Mount Welcome at Roebourne, on the north-west coast of the colony, was determined to be

about S. lat. 20° 46′ 6″, E. long. 117° 7′ 55″. The courses of the following rivers were correctly traversed and mapped:—De Grey River, 100 miles; Turner, 25 miles; Yule, 50 miles; Sherlock, 50 miles; Fortescue and tributaries, 300 miles; Robe, 50 miles; Cane, 70 miles; Ashburton and tributaries, 150 miles; making a total of 795 miles. The heights of mountains have not yet been calculated, but a triangulation was made of the country between the De Grey and Ashburton Rivers, covering an area of 30,000 square miles. Maps of the districts above-mentioned are in preparation, but are not yet completed. The report of the work performed during the current half year will, no doubt, contain some interesting information, as a party, under the command of Mr. Alex. Forrest, started in January last to undertake the exploration of the previously unexamined tract of country in the north-west lying between the De Grey and Victoria Rivers.

BARON VON MÜLLER, in a letter to Petermann's *Mittheilungen*, states that Mr. Tietkens, who accompanied Giles on his two last journeys, has left Adelaide for Beltana at the head of a camel expedition fitted out by Mr. Elder for exploration along the region lying inwards from the great Australian Bight. Mr. Tietkens informed us when he was in this country that he was confident that long stretches of fine pasture-land would be found at various parts of this region, and one of his objects is apparently to find these. Baron von Müller speaks highly of Mr. Tietkens's qualifications as an explorer and surveyor, and expects that in the course of the next few years he will do much to add to our knowledge of the geography of the Australian interior.

M. SOLEILLET, the French explorer of North Africa, has arrived at Marseilles from St. Louis, in Senegal. He has been received by the Geographical Society of that city, and will deliver a lecture on the necessity of opening the way between Senegal and Algeria, *viâ* Timbucktoo. It is said that he will, at the suggestion of *Akhbor*, be called to Algiers by the Governor-General before going to Lyons and Paris, where he will deliver lectures on the same subject. In this connection we may state that an interesting ceremony will take place in a few days. The inhabitants of a small country place in the Eure department will remove to another site the grave of René Caillet, the celebrated Timbucktoo explorer, who died in 1838, and was the first laureate of the French Geographical Society. The Society will bear the expenses of exhumation, and send delegates to witness it. One of them will be M. Soleillet.

IN No. 20 of *Globus* of this year is a short article of some interest showing the physical and moral changes in the population of Siberia by the mixture of Russian colonists with the native races.

WE take the following from the *Gardeners' Chronicle*:—Mr. Goldie, the naturalist, who has passed the last eighteen months in New Guinea in search of plants for Mr. B. S. Williams, of Holloway, has, the *Brisbane Courier* states, collected an immense number of animals, birds, and insects, besides valuable botanical specimens, and believes that a large number of these are entirely unknown. He claims to have found an entirely new species of kangaroo. He has brought with him a native from the coast tribes, a good-looking lad of indistinct Malay origin, whose long frizzly hair, tied round with a string, is worn standing straight up. The natives of the inland tribes Mr. Goldie states to be entirely different from those on the coast in both appearance and customs, but all, he says, are friendly and good-natured, and not given to the deeds of ferocity lately detailed by us on the authority of the residents at a *bêche-de-mer* station. Mr. Goldie was of the party that made its way to the coast, crossing about twenty flooded rivers, and losing horses and baggage, and states that although they crossed some high ranges they never reached the dividing range, on the other side of which, the general belief amongst the party was, that payable gold would be found. The natives in the interior are, it appears, so awed at the sight of a white man as to obviate any risk of molestation. The custom of a tribe with whom Mr. Goldie's party came in contact, suggested to them the probable origin of the rumours that have been always current of a race of tailed men in some remote corner of the globe. These natives wear artificial tails of such cunning construction as to entirely mislead a casual observer. They are entirely naked, except for the caudal ornament, which is a plait of grass fastened round their loins by a fine string, and depending behind to about half-way down their legs. Possibly the missing link that has so baffled Darwin has only lately become extinct in New Guinea, and these descendants, ashamed of their degeneracy, keep up the tradition of a noble ancestry by simulating their distinguishing characteristic.

THE Austrian *Monatschrift für den Orient* of May contains an article of much practical and some ethnological value on the Nations of the Turkish Empire as factors in the National Economy; he reviews the condition of the various industries, and the character of the various ethnical elements of the Turkish dominions. Herr A. von Wassberg contributes a paper on the Migrations of the Inhabitants of the Ionian Islands, while Herr Schick continues his elaborate papers on Agriculture in Palestine.

THE May number of Petermann's *Mittheilungen* gives the chief place to a long and careful article by M. Lindeman on the North Coast of Siberia between the Mouths of the Lena and Behring Straits. Herr Lindeman traces the history of exploration in the region from 1630 to the present time, and follows this with a description of the coasts and islands. The article is accompanied by an excellent map in two sheets. Dr. Emin Bey, Governor of the Egyptian Equatorial Provinces, contributes an interesting Journal of a Journey from Mruli to the chief town of Unyoro, abounding with valuable notices on the country and people.

THE March number of the *Bulletin* of the Paris Geographical Society contains, as its first article, the first part of a learned paper by M. de Saulcy on the cities of Upper Louten, the Syria of the Ancient Egyptians. Other papers are on the frontiers of Russia in Central Asia, by M. de Ujfalvy; explorations of the Cunene, by M. Nogueira; and the dried-up rivers of the Dobruja, by Herr F. Kanitz.

NOTES

THE University of Cambridge proposes to confer the honorary degree of LL.D. upon the following, among others:—Mr. Justice Grove, Mr. W. Spottiswoode, President of the Royal Society, Mr. Henry J. S. Smith, Savilian Professor of Geometry, Oxford, Prof. Huxley, Mr. H. C. Sorby, F.R.S. The Rede lecture will be delivered in the Cambridge Senate-house at 2.30 on Wednesday, June 11. The lecturer, the Rev. W. H. Dallinger, has chosen the following subject:—"The Origin of Life as illustrated by the Life Histories of the Least and Lowest Organisms in Nature."

THE Forty-Ninth Annual Meeting of the British Association will commence at Sheffield on Wednesday, August 20, 1879. The President Elect is Prof. G. J. Allman, LL.D., F.R.S., Prof. L.S. Vice-presidents Elect—His Grace the Duke of Devonshire, K.G., F.R.S., the Right Hon. the Earl Fitzwilliam, K.G., the Right Hon. the Earl of Wharncliffe, W. H. Brittain (Master Cutler), Prof. T. H. Huxley, Sec. R.S., Prof. W. Odling, F.R.S. General Secretaries—Capt. Douglas Galton, C.B., F.R.S, Philip Lutley Sclater, Ph.D., F.R.S. Assistant

Secretary—J. E. H. Gordon, B.A. General Treasurer—Prof. A. W. Williamson, Ph.D., F.R.S. Local Secretaries—H. Clifton Sorby, F.R.S., J. F. Moss. Local Treasurer—Henry Stephenson. The following are the sections and their presidents:—A.—Mathematical and Physical Science.—President: George Johnstone Stoney, F.R.S. B.—Chemical Science.—President: Prof. James Dewar, F.R.S. C.—Geology.—President: Prof. P. Martin Duncan, F.R.S. D.—Biology.—President: Prof. St. George Mivart, F.R.S. E.—Geography.—President: Clements R. Markham, C.B., F.R.S. F.—Economic Science and Statistics.—President: G. Shaw Lefevre, M.P., Pres. S.S. G.—Mechanical Science.—President: J. Robinson, Pres. Inst. Mech. Eng. This list of sectional officers will be completed and will be submitted to the General Committee on Wednesday, August 20. The Reception Room will be opened on Monday, August 18, at 1 P.M., and on the following days at 8 A.M., for the issue of tickets to Members, Associates, and ladies, and for supplying lists and prices of lodgings, and other information, to strangers on their arrival. No tickets will be issued after 6 P.M. Tickets for the meeting may also be obtained from August 1 until August 6, on application to the General Treasurer, Prof. A. W. Williamson, British Association, University College, London, W.C. The first General Meeting will be held on Wednesday, August 20, at 8 P.M., when Dr. William Spottiswoode, Pres. R.S., will resign the chair, and Prof. G. J. Allman, F.R.S., President Elect, will assume the Presidency, and deliver an address. On Thursday evening, August 21, at 8 P.M., a *soirée;* on Friday evening, August 22, at 8.30 P.M., a discourse by William Crookes, F.R.S., on Radiant Matter; on Monday evening, August 25, at 8.30 P.M., a discourse by the Rev. W. H. Dallinger, on the Life Histories of the Minutest Organic Forms, and their Bearing on the Doctrine of the Origin of Species; on Tuesday evening, August 26, at 8 P.M., a *soirée;* on Wednesday, August 27, the concluding General Meeting will be held at 2.30 P.M. On Saturday evening, August 23, W. E. Ayrton, Esq., will deliver a lecture to the Operative Classes, on Electricity as a Motive Power. Tickets can be purchased of the local Secretaries. No report, paper, or abstract can be inserted in the Report of the Association unless it is in the Assistant Secretary's hands before the conclusion of the Meeting. A room will be provided for the reception of apparatus and specimens illustrative of papers communicated to the Sections. Excursions to places of interest in the neighbourhood of Sheffield will be made on Thursday, August 28.

WE regret to hear of the decease of M. Edouard Pictet, of Geneva, at the early age of forty-four. He was the son of Prof. F. J. Pictet, of the same city, formerly a writer on neuropterous, insects, latterly a palæontologist, who died about seven years ago. M. E. Pictet inherited his father's scientific tastes, and in 1865 published a "Synopsis des Névroptères d'Espagne," based upon a journey made in that country a few years previously. Latterly he had been much occupied in investigating the physical conditions of the Lake of Geneva, in company with Forel and others of his compatriots; and his official duties, municipal and otherwise, took up much of his time. He visited London at the time when the Loan Exhibition of Scientific Instruments was on view at South Kensington. The family Pictet has included amongst its members several illustrious scientific men, and is one of which Switzerland is justly proud. M. Raoul Pictet, the celebrated investigator of the liquefaction of gases, is a cousin of the subject of this note, and M. H. de Saussure also belongs to a collateral branch of the same family.

THE death is announced of Mr. Thomas Wills, F.C.S., who has acted as secretary to the Chemical Section of the Society of Arts since it was first founded in 1874. Mr. Wills was born in 1850, in Devonshire; he was educated at University College School and at King's College. In the early part of 1868 he became an assistant to Dr. Odling at St. Bartholomew's Hospital, and in the latter part of that year, on Dr. Odling being elected to the Fullerian Professorship at the Royal Institution, Mr. Wills was appointed his official assistant. In 1873 he resigned this post to accept the position of Demonstrator in Chemistry at the Royal Naval College. The subject to which Mr. Wills specially devoted himself was the application of chemistry to the manufacture of gas, and on questions connected with this subject he was rapidly becoming an authority. He was a constant contributor to the *Transactions* of the Chemical and other societies. For several years he acted as secretary to Section B (Chemistry) of the British Association, and he was a member of the Association Committee for ascertaining the best methods of improving the illuminating power of coal-gas. His most recent piece of work was in connection with the subject of electric lighting. Dr. Tyndall, in giving evidence upon the electric light before a Committee of the House of Commons, referred to Mr. Wills as having discovered that oxides of nitrogen were given off by the voltaic arc, thus rendering the light to that extent injurious.

IN the Paris Academy, Dr. Oppolzer has been elected a Corresponding Member in the Astronomical Section in place of the late Prof. Argelander, and M. Alphonse Favre in place of the late Prof. Leymerie in the Section of Mineralogy.

THE professors of the Museum of Paris have presented two candidates for filling the place vacated by the death of Claude Bernard, who was professor of general physiology in the establishment. The first candidate is M. Boubez, of the Institute, and the second M. Moreau.

A GENERAL MEETING of the Mineralogical Society of Great Britain and Ireland will be held at the Meteorological Office, 116, Victoria Street, on Tuesday, June 3, at 8 P.M., when the following papers will be read:—On abriachanite, a new Scottish mineral, by Prof. M. F. Heddle and D. W. H. Aitken; on haughtonite, a new mica, by Prof. M. F. Heddle; on christophite from St. Agnes, Cornwall, by J. H. Collins, F.G.S.; minerals from Japan, by John Milne, LL.D., and T. Davies, F.G.S.; additional note on penwithite, by J. H. Collins, F.G.S. The chair will be taken by Prof. T. G. Bonney, M.A. Other communications intended to be read at this meeting should be sent to J. H. Collins, secretary, at the Scientific Club, 4, Savile Row, London, W., not later than Saturday, May 31.

THE first public act passed by the U.S. Congress during the present session, was one making an appropriation of 200,000 dollars for the construction, under the direction of the Secretary of the Treasury, for the National Board of Health of a vessel provided with suitable refrigerating apparatus, for the purpose of determining the possibility of destroying the yellow fever infection by intense cold. The act as first introduced had special reference to the apparatus of Prof. Gamgee, but as passed it is within the power of the Secretary to select any device that will, in the opinion of the National Board of Health, best answer its purpose.

PROF. DUGES, of Mexico, in a recent letter to the Smithsonian Institution, speaking of the enormous numbers of the common cow-bird, or *Molothrus pecoris*, in his neighbourhood, refers to a certain flight supposed to have been about 12,000 yards in length, six yards wide, and probably over a yard deep. He estimates the number contained in it to be from 9,000,000 to 10,000,000. A flock of 1,000 or 2,000 of these birds is very common, generally mixed with the *Xanthormus icterocephalus*, and to some extent with the red-winged blackbird.

WE learn that Dr. Edouard Bornet, of Paris, eminent for his researches on the structure and reproduction of algæ, and author

of other works on that order, and Prof. Heinrich Gustav Reichenbach, fils, Director of the Botanic Gardens, Hamburg, alike distinguished for his special knowledge of, and publications on, the Orchidaceæ, have been elected Foreign Members of the Linnean Society.

Of eleven female candidates who presented themselves for the first examination for the degrees of London University, six were placed in the division of honours, four were declared to be entitled to exhibitions, and one was second in the whole list of candidates. There were only two failures.

Dr. Swan M. Burnett, of Washington, has recently made some examinations for the purpose of ascertaining whether the negro in the United States is affected with colour-blindness to the same degree as the white race. He has examined 3,050 coloured children, from six to eighteen years of age, in the public schools of the district of Columbia, of whom 1,359 were males, and 1,691 females. Of these, twenty-two boys were colour-blind (or 1·6 per cent.), and two girls (or 0·11 per cent.) The percentage of colour-blindness among the whites in an aggregate of about 40,000 examinations is 3 per cent. for males, and 0·26 for females. The negro appears, therefore, to be less liable to this defect than the white race. The examinations were made in strict accordance with the plan proposed by Prof. Holmgren, of Upsala, Sweden, and used so extensively in making similar examinations in Europe.

A number of Jablochkoff candles have been employed by the French government, for illuminating, by night, an exhibition held at the École des Beaux Arts, for the benefit of schools. The success is so great, that it has been proposed by M. Turquet, Director of Fine Arts, to open by night the exhibition of Pictures, held now at the Palais de l'Industrie. It is stated that not less than 250 candles will be lighted on this occasion, which will require an engine of more than 300 horse-power. But the expense, although considerable, will be nothing in comparison with the receipts expected. The arrangements will be made during the temporary closing at the end of May, and the electric light be put in operation during the month of June. It is likely that the arrangements will be utilised by the Exhibition of Arts applied to Science, which will be held from July to November.

The select committee to investigate into the explosion on board Her Majesty's armour-plated turret-ship *Thunderer* propose to make their experiments in the most public manner, in order fully to establish the stability of the guns constructed on the Woolwich system under all the conditions of the service, and the liability of any gun to be destroyed by unfair means. The burst gun has been taken into the inspection department for examination, and the sister 38-ton gun will be taken to the proof butts in the marshes to be fired.

The June *Scribner* will contain the first of a series of articles on "Edison and his Inventions," by Mr. Edwin M. Fox. The opening paper will be devoted to the electro-motograph and its applications. The six-years' growth of this remarkable invention will be described by Mr. Fox with much incidental light on the inventor's methods of work.

The *Colonies and India* furnishes some interesting particulars respecting the so-called "vegetable ivory," which is now so much used as a substitute for ivory. The vegetable ivory nut is the produce of a species of palm found wild in South America and Africa. Inside the hard shell is the white kernel, which being softer than ivory and easily carved, as well as readily dyed, and being less brittle than bone, is largely used in making buttons, &c. The unripe fruit consists of a green shell, containing a watery fluid, which, as the nut ripens, gradually thickens until it becomes a pulpy mass, and eventually hardens into solid matter. The water, though bitter to the taste, is wholesome, and often renders invaluable service to travellers, who cannot otherwise obtain water to drink. The tree (*Phytelephas macrocarpa*) on which the fruit grows is unlike an ordinary palm, having little or no stem and drooping downwards, especially when the weak branches are overweighted by the six or seven bunches of nuts, each containing six or seven seeds, inclosed in thick heavy shells and outer sheath, and weighing altogether from 20 to 24 lbs.

A recent valuable memoir by Prof. Stefan to the Vienna Academy treats of the relation between radiation of heat and temperature. In the first part he discusses Dulong and Petit's experiments, from which the conclusion was drawn that the amount of heat radiated from a body increases in a geometrical progression, when its temperature increases in an arithmetical. Prof. Stefan points out that the observations of these physicists may be calculated with great approximation by another very simple formula, according to which the amount of heat radiated from a body is proportional to the fourth power of its absolute temperature. It is shown that while the law of geometrical progression corresponds to Dulong and Petit's numbers better than that of the fourth powers, these numbers (because of defects in experiment) are not suited for rigorous proof of the law as to heat radiation. Further, it is shown that the formula of the fourth powers agrees with the observations of Provostaye and Desains much better than that of Dulong and Petit. In the second part of the memoir, cooling experiments are utilised for determination of heat-radiation in absolute measure. In the third it is shown that the formula of the fourth powers agrees fairly well with Draper's experiments on heat radiation of a glowing platinum wire, and Ericson's on that of a glowing block of iron. The fourth part contains some remarks on the sun's temperature. From the intensity of solar radiation as determined by Pouillet, the emissive power of the sun being considered = 1, we obtain, according to the formula of the fourth powers, the sun's temperature = 5580°. Nearly the same number comes by this formula from Soret's comparative determinations of the radiation of the sun and that of a glowing disk of zirconium.

A new grass, *Reana luxurians*, has been imported into Ceylon from Java, and is stated to be doing well, having attained a height of 8 feet in three months. It is said to contain a large amount of saccharine matter, and cattle and horses eat it freely.

Extraordinary finds of gold have lately occurred in the gold-fields of Dutch and French Guiana and are causing great excitement.

A rich deposit of lead and silver has just been discovered near the Thames River, New Zealand. The ore is reported to contain 50 per cent. of lead, with about two pounds worth of silver, and 9 dwt. 13 grs. of gold per ton.

According to the Japan papers, a singular innovation has lately taken place in an ancient branch of the trade of the country. Mixadzu, a town in the province of Tanbano-kuni, has always been famous for the manufacture of crape, the principal industry in the province. Hitherto, however, the crape has been manufactured from Japanese silk, but it has recently been discovered that the kind of silk required can be imported from Corea of better quality and much cheaper than it can be procured at home. A number of Japanese merchants have, therefore, formed themselves into a company with the object of manufacturing crape from Corean silk, and have already despatched one of their number to Corea to make the necessary arrangements.

On Tuesday last week an enormous avalanche descending from the Jungfrau swept through the valley of Stufenstein, carried away a whole forest, and created the utmost consternation in the neighbourhood. So far as is known no lives were lost.

THERE has been a slight eruption of Vesuvius for some days.

A VERY distinct Fata Morgana was observed above the village of Zhor, near Kozlau in Bohemia, on the 2nd inst.

M. JULES FERRY, the French Minister for Public Instruction publishes a report on the re-establishment of the Museum of Pedagogy, which was created by M. Jules Simon at the Ministry of Public Instruction, and described in NATURE at the time. This report shows that the original idea of such a collection must be attributed to M. Jullien of Paris, one of the best pupils of the celebrated Pestalozzi, who established it in 1817. The direction of the new museum will be given to a general inspector of primary instruction specially appointed for the purpose. This museum will be also a central library for primary education in France.

WE have received two numbers (February and March) of the *College Journal*, issued in connection with the Georgetown (R.C.) College, U.S. The latter number contains an article resuming some of the more recent conclusions with regard to sun-spots.

WE have on our table the following books :—"Description of Vertebrate Remains," Prof. Joseph Leidy (Collins, Philadelphia); "Characeæ Americanæ," part 1 (Timothy F. Allen, New York; "Sport in British Burmah, Assam, and the Cassyah and Jyntiah Hills," Lieut.-Col. Pollok (Chapman and Hall); "Obituary Notices of Astronomers," Edwin Dunkin (Williams and Norgate); "On the Nature of Life," Ralph Richardson (H. K. Lewis); "The Gault," F. G. Hilton Price (Taylor and Francis); "Ausgestrahlte Licht," Edw. L. Nichols (E. V. Huth, Göttingen); "The Students' Text-Book of Electricity," Henry M. Noad (Crosby Lockwood); "Atlas of Histology," part 3, E. Klein and E. N. Smith (Smith, Elder); "Organic Chemistry," Hugh Clements (Blackie and Sons); "Evolutions Old and New," S. Butler (Hardwicke and Bogue); "Treatise on Natural Philosophy," vol. i. part 1, Thomson and Tait (Cambridge University Press); "Mechanics," R. S. Ball (Longmans); "Health and Occupation," B. W. Richardson (S.P.C.K.); "Electric Lighting," J. N. Shoolbred (Hardwicke and Bogue); "Hydro-Incubation," Thos. Christy (Christy and Co.); "Principles of the Algebra of Logic," Alex. Macfarlane (Douglas); "Geological Map of Northumberland," G. A. Lebour (Andrew Reid); "The Ibis" (General Index 1859–76), Ed. O. Salvin (Van Voorst); "Middleton's Impeachment of Modern Astronomy" (Judd and Co.); "Hints on the Pronunciation of the French Language," L. J. V. Gerhard (Hachette and Co.); "Analytical Chemistry," Dr. John Muter (Wm. Baxter); "Pharmaceutical Chemistry," Dr. John Muter (Wm. Baxter); "Manchester Science Lectures for the People, 1877, 1878, 1879" (John Heywood); "Australasia," A. R. Wallace (E. Stanford).

THE additions to the Zoological Society's Gardens during the past week include a Rhesus Monkey (*Macacus erythræus*) from India, presented by Mr. H. Winsor; a Vulpine Phalanger (*Phalangista vulpina*) from Australia, presented by Mr. A. Elder; a Ring-necked Parrakeet (*Palæornis torquatus*) from India, presented by Mr. F. S. Prince; a Herring Gull (*Larus argentatus*), European, presented by Mr. C. H. de Loecker; a Rough Terrapin (*Clemmys punctularia*) from Trinidad, presented by Surgeon-Major C. J. Weir; a Puma (*Felis concolor*) from America, purchased; two Squirrel Monkeys (*Saimaris sciurea*) from Guiana, two Plantain Squirrels (*Sciurus plantani*) from Java, a blue Jay (*Cyanocitta cristata*) from North America, an Ariel Toucan (*Ramphastos ariel*) from Brazil, a Sclater's Curassow (*Crax sclateri*) from South America, deposited; a Zebu (*Bos indicus*), two Geoffroy's Doves (*Peristera geoffroyi*), a Yellow-legged Herring Gull (*Larus leucophæus*), bred in the Gardens.

ON THE INFLUENCE OF PRESSURE UPON THE SPECTRA OF GASES AND VAPOURS

HERR G. CIAMICIAN has recently communicated to the Vienna Academy the results of a series of interesting experiments made with a view of investigating the influence of pressure upon the spectra of gases and vapours. From the somewhat lengthy report we gather the following data, which may prove acceptable to those of our readers who are actively engaged in spectroscopic research. The spectra of the three halogens, chlorine, bromine, and iodine, show on the whole the same peculiarities when the pressure is increased. The bright lines become diffused, sometimes a little broader, without, however, changing into bands. Besides this, a continuous illuminated background appears, which increases in brightness with the pressure, and which often overpowers the lines. This is particularly the case with iodine, where, eventually, nothing but a continuous spectrum is seen; while with chlorine and bromine certain lines yet remain brighter than the continuous light. The behaviour of certain lines in the red part of the spectra of chlorine and bromine is remarkable, as they retain their original sharpness and fineness under any pressure.

The spectrum of sulphur does not change at all under increased pressure, the lines retain their full sharpness, and a continuous bright background appears only at the red end of the spectrum. In the case of phosphorus and arsenic there is no reaction at all, as here even the continuous background does not appear. Herr Ciamician thinks that it has been overlooked hitherto that arsenic under a moderate pressure, and without a Leyden jar being inserted into the electric current, gives a spectrum of the first order, viz., a nearly continuous one, which, when the density becomes greater and the Leyden jar is inserted, disappears, and is replaced by a line spectrum.

Metals behave very differently to the non-metals just mentioned; here a real band-like extension of the spectral lines takes place, while the continuous light remains subdued. In the mercury spectrum the enlargement of the green and violet lines are specially noteworthy. In the sodium spectrum Herr Ciamician could observe the enlargement, which is very considerable, only with the *reversed*, *i.e.*, dark D line, as he could not observe the spectrum emitted in any other way than through a layer of sodium vapour. Under high pressure sodium gives a continuous background in the immediate neighbourhood of the D line, and upon this the reversed D line appears. At first it is seen as a double line, but soon afterwards the two lines flow into one in consequence of the enlargement; the dark band thus formed becomes wider and wider, until it finally covers the whole background which appeared in continuous light.

SCIENTIFIC SERIALS

THE *Revue Internationale des Sciences* (April, 1879) contains the following papers :—On symbiosis, by Prof. de Bary.—On the physical and intellectual evolution of woman among the different races, by M. Zaborowski.—On the chromatic function of the octopus, by Dr. L. Frédéricq.—On the source of muscular power, by A. Flint.—On the constitution of the blood plasma, by Dr. L. Frédéricq.—On the nature of lichens, by Dr. J. Müller.—On the entozoa of insects, by Osman Galeb.

THE *Verhandlungen der naturforschenden Gesellschaft zu Freiburg in Baden* (vol. vii. part 3) contains the following papers :—On a generalisation of Jacobi's reversion problem of Abel's integral, by F. Lindemann.—On the determination of the coefficient of elasticity through the bending of short rods, by K. R. Koch.—Microscopical observations on the growth and melting away of alum crystals in solutions of isomorphous substances, by F. Klocke.—On an automatic water and air-pump, by L. von Babo.—New discoveries in the Freiburg flora, by J. Schill.—On some minor actions of wind, by F. C. Hentici.

THE *Archives des Sciences physiques et naturelles* (April, 1879) contains the following papers :—Remarks on the geological review of Switzerland for 1878, by Ernst Favre.—On the *seiche* occasioned by the cyclone of February 20 last, by Prof. Ph. Plantamour.—On the hurricane of February 20, by F. A. Forel.—On the presence of tannine in vegetable cells, by J. B. Schnetzler.—On the meteorology of the Presidency of Bombay, by Ch. Chambers.—Researches on electricity, by Gaston Planté.—On the compounds derived from oxypropylbenzoic acid, by R.

Meyer and J. Rosicki.—On a new glucosid obtained from *Lupinus luteus*, by E. Schulze and J. Barbieri.—On the action of bromine upon some paraffins of high molecular weights, by V. Merz and F. Weith.—On cantharic acid, by J. Piccard.—On some reactions of silver ultramarine, by K. Heumann.—On the reactions of nitrosyl silver, by W. Zorn.—On the transformation of undecylenic acid into undecylic acid ($C_{11}H_{22}O_2$), by F. Krafft.—On the stipulæ and their *rôle* in inflorescence and the flowers of plants, by M. Clos.

SOCIETIES AND ACADEMIES

LONDON

Royal Society, May 8.—"On the Relation between the Diurnal Range of Magnetic Declination and Horizontal Force, as observed at the Royal Observatory, Greenwich, during the years 1841 to 1877, and the Period of Solar Spot Frequency." By William Ellis, F.R.A.S., Superintendent of the Magnetical and Meteorological Department, Royal Observatory, Greenwich. Communicated by Sir George Airy, K.C.B., F.R.S., Astronomer-Royal.

In this paper the author draws attention to the long series of magnetical observations which have been made at the Royal Observatory under the direction of Sir George B. Airy, K.C.B., Astronomer-Royal, and remarks that examination of the Greenwich records shows that, in addition to the ordinary diurnal and annual changes, there appears to exist, in the magnetic diurnal ranges, an inequality, resembling in its features the well-established eleven-year sun-spot period.

This is not by any means the first time that such relation has been discussed, it being, by some investigators, considered to be already sufficiently well proved. But it appeared that the long series of Greenwich observations might be well applied as an independent test of the accuracy of the supposed relation.

The results for declination and horizontal force only are used, the strict continuity of the record by the vertical force instrument being somewhat broken.

The monthly mean diurnal range of declination, or of horizontal force, is taken to represent the magnetic energy of the month relatively to other months, and smoothed curves of the magnetic numbers and Dr. Wolf's sun-spot numbers are drawn, which show a remarkable similarity.

The epochs of minimum and maximum being tabulated, it is found that, on the average, the mean magnetic epoch follows the sun-spot epoch by 0·27 of a year. By another method of tabulation the difference becomes reduced to 0·10 of a year.

It seemed further desirable to ascertain whether the more fitful changes of the phenomena in any way also correspond. To make this comparison, the magnetic numbers, instead of being smoothed, as before described, were now cleared only of the *average* annual inequality, and compared with the *actual* monthly sun-spot numbers. Curves are given, founded on these numbers, and they show some very remarkable correspondences between the more rapid sun-spot and magnetic variations, especially between the years 1869 and 1873.

Further inquiry seems to point to a variation in the annual inequalities of magnetic diurnal range.

The following are the general conclusions supposed to be derived from the whole inquiry :—

1. That the diurnal ranges of the magnetic elements of declination and horizontal force are subject to a periodical variation, the duration of which is equal to that of the known eleven-year sun-spot period.

2. That the epochs of minimum and maximum of magnetic and sun-spot effect are nearly coincident; the magnetic epochs, on the whole, occurring somewhat later than the corresponding sun-spot epochs. The variations of duration in different periods periods appear to be similar for both phenomena.

3. That the occasional more sudden outbursts of magnetic and sun-spot energy, extending sometimes over periods of several months, appear to occur nearly simultaneously, and progress collaterally.

4. That it seems probable that the annual inequalities of magnetic diurnal range are subject also to periodical variation, being increased at the time of a sun-spot maximum, when the mean diurnal range is increased, and diminished at the time of a sun-spot minimum, when the mean diurnal range is diminished.

Conclusions Nos. 1, 2, and 3 appear to be sufficiently certain, but the evidence in favour of No. 4 is not so decisive.

Chemical Society, May 15.—Mr. Warren de la Rue, president, in the chair.—The following papers were read :—On nitrification, part ii., by R. Warington. The author finds that light hinders the conversion of ammonia salts into nitrites and nitrates, by the nitrifying ferment; the presence of carbonate of calcium is indispensable; nitrification is stopped by a temperature of 40° C.; there is a period of incubation after the addition of the ferment, during which no effect is produced; this period is increased by using stronger solutions of ammonia salts, but diminished by raising the temperature; in some cases nitrites, in others nitrates are formed.—On the alkaloids of the Veratrum family, part iii., by C. R. A. Wright and A. P. Luff. The authors have obtained two new crystalline alkaloids, pseudojervine, melting at 299°, and rubijervine, melting at 237°, and a new amorphous base veratralbine, from Veratrum album.—On the alkaloids of the Veratrums, part iv., by C. R. A. Wright. From Veratrum viride the author has obtained jervine, pseudojervine, rubijervine, veratrine, and cevadine.—On the alkaloids of the aconites, part iv., by C. R. A. Wright and A. P. Luff. The authors have examined Japanese aconite roots, and obtained a base Japaconitine melting 185°, resembling aconitine. By saponification a new base Japaconin was formed. The yield of alkaloids from Japanese aconite is about three times that from *A. napellus*.—On the action of hydrochloric acid on manganese dioxide, by S. U. Pickering. The author criticises, and in the main disagrees with the conclusions of W. W. Fisher as to the existence of manganese tetrachloride.—On some reactions of the ammoniochloride of magnesium, known as magnesia mixture, by H. D'Arcy Power. The author has observed that potassium salts, and especially potassium iodide, precipitate magnesium hydrate from this solution to an extent equal to 46 per cent. of the magnesia present.—The composition of cow's milk in health and disease, by A. Wynter Blyth. The author has separated from whey two alkaloidal bodies, by precipitation with nitrate of mercury, galactine, and lactochrome; also a supposed glucoside, precipitated by tannin. He gives details as to the composition of milk from healthy and diseased cows, and concludes that a cow suffering from very acute disease may give milk differing in no essential feature from normal milk.—On the effect of alcohol on saliva, and on the chemistry of digestion, by W. H. Watson. Alcohol hinders markedly the conversion of starch into sugar by saliva; a trace of hydrochloric acid, on the other hand, increases the rapidity of the conversion.

Anthropological Institute, April 29.—Mr. E. Burnet Tylor, D.C.L., F.R.S., president, in the chair.—The following new Members were announced :—W. S. Duncan and Edmund Knowles Binns.—A paper was read by Col. H. Yule, C.B., entitled "Notes on Analogies between the Indo-Chinese Races and the Races of the Indian Archipelago." The author first stated that the paper was written abroad some nine or ten years ago, and had been unaltered since. A large number of analogous manners and practices were adduced, common alike to the peoples of the two regions, which Col. Yule, in conclusion, considered would singly be of no value as arguments for some original close bond of kindred between the races of the Indo-Chinese countries and those of the Archipelago. But when thus accumulated they must surely be admitted to have great weight, and to be too numerous and striking, considering the comparative contiguity of the regions occupied by those races, and the physical resemblances which often occur among those of them, the most remote from one another to be due merely to the parallel development of isolated bodies of men in like stages of growth.—A paper was also read by the Rev. James Sibree, jun., of the London Missionary Society, upon relationships and the names used for them among the peoples of Madagascar, chiefly the Hovas, together with observations upon marriage customs and morals among the Malagasy. It was remarked that in the Malagasy language there are in many classes of words strange deficiencies, as compared with English, while, at the same time, in other groups there is great fulness and minuteness of distinction. Notice was taken of the low standard of morals generally prevailing through the island, and of the evidence of this given by the dictionary, in the absence of such words as chastity, purity, and allied terms. The paper concluded by a description of the class distinctions among the Hovas, there being three main divisions: the Andrians or nobles, the Hovas or commoners, and the Andevo or slaves, the subdivisions of which were also pointed out, together with the restrictions upon marriage between the different ranks of native society.

Entomological Society, May 7.—J. W. Dunning, M.A., F.L.S., vice-president, in the chair.—M. N. Joly, of Toulouse, was elected a Foreign Member.—Mr. H. J. Elwes exhibited a collection of lepidoptera made in Asia Minor by Dr. Staudinger.—Dr. Wallace exhibited a collection of lepidoptera made by his son in the United States of Columbia.—Mr. W. L. Distant exhibited a West African specimen of the large water-bug, *Hydrocyrius Columbiæ*, Spin., common also to Madagascar and the Neotropical region; and read extracts from a letter received from Calabar district as to its power of attaching itself to stones by its tarsal claws, and even lifting large ones by the same means.—The Secretary exhibited an alcoholic specimen of a trichopterous insect belonging to the *Leptoceridæ*, forwarded from Brazil by Dr. Fritz Müller, and remarkable on account of its showing very distinctly the branchiæ lately discovered in the imago stage of this order by Dr. Palmèn.—Dr. Wallace stated that, as the result of large numbers of experiments upon the rearing of silk-moths of various species, he had come to the conclusion that the ordinary *Bombyx mori* is the only species that could be profitably reared in this country.—Sir John Lubbock forwarded for exhibition two species of *Bombycidæ* from Adelaide, South Australia, together with their cocoons, eggs, and larvæ, and a letter from Mr. G. Francis giving details of the life-history of the specimens exhibited.—Mr. McLachlan read a note received from Mr. W. J. Wilson, residing in North-west India, referring to the appearance of locust-swarms in that district.—Dr. Fritz Müller communicated a paper entitled "Notes on the Cases of some South Brazilian Trichoptera."—Mr. Wood-Mason read a paper entitled "Morphological Notes bearing on the Origin of Insects," and exhibited microscopical preparations in illustration.

Victoria (Philosophical) Institute, May 19.—After the election of several new members, a paper on the ethnology of the Pacific was read by the Rev. S. J. Whitmee, illustrated by diagrams and an ethnological map of the Pacific, which Mr. Whitmee had prepared during his long residence in many of the various groups of islands in that ocean; many present afterwards joined in the consideration of the paper, in which the author gave many reasons for believing that in earlier times a considerable intercommunication took place between the Continent and the islands, and that there was no reason for believing that, from the evidence already obtained, any arguments could be drawn against the unity of the human family.

PARIS

Academy of Sciences, May 12.—M. Daubrée in the chair.—The following papers were read:—On vision of colours, and particularly the influence exerted on vision by coloured objects moving circularly, when observed comparatively with similar objects at rest, by M. Chevreul. A third extract from his work on the subject.—On the bases derived from aldol-ammonia, by M. Wurtz.—Note relative to a communication of M. Meunier; and on similar water-spouts observed recently, by M. Faye. The accounts are cited as giving strong confirmation of his theory.—Maps of the coast of Tunis and Tripoli, by M. Mouchez. These eleven maps, covering about 250 leagues of coast, are the outcome of M. Mouchez's recent voyage in the *Castor*. The Gulf of the Greater Syrtis seems destined to be always desert, and a dread to navigators; the fanatical and hostile Nomads seem to visit its borders only to pillage wrecked vessels. The coasts of the lesser Syrtis are more hospitable under the government of Tunis. In view of the expensiveness of M. Roudaire's scheme, M. Mouchez wishes it were undertaken by others than the French. The tides are very sensible and pretty regular in the Gulf of Khabs. Unfortunately the natives destroyed the scales erected, so that the author can only give approximate figures.—On the history of the theory of the thrust outwards in slanting arches, by M. de la Gournerie.—On the transformations of the second order of hyperelliptic functions, which, applied twice successively, produce duplication, by M. Borchardt.—M. Oppolzer was elected Correspondent in Astronomy in room of the late M. Argelander, and M. Favre Correspondent in Mineralogy in room of the late M. Leymerie.—On the effects of inhalation of spirit of turpentine, by M. Poincaré. His observations were both on workmen and animals. The disorders produced in the former are headache, giddiness, irritability, pricking and tearfulness in the eyes, and weakness of sight, irritations of pharynx and larynx, vomiting, &c. Through habit, men get to bear the vapours longer. The troubles are more intense and constant with spirits of turpentine from Hungary and America than with those of French origin. Animals which died from the acute poisoning in confined space generally showed congestion and free drops of the condensed spirit in the blood.—On the means used by M. Gyldén for regulating trigonometric developments representing perturbations, by M. Callandreau.—On a new form of co-ordinates in the problem of two bodies, by M. Gyldén.—On two applications of the method of MM. Fizeau and Foucault. These rest (1) on substitution of a known system (in which the distance of the lines is determined by the condition that the wave-length of D is 0·0005888), and (2) on the use of formulæ of dispersion. The first application is the measurement of the thickness of a parallel crystalline plate; the second, study of the dispersion of double refraction of a plate.—Thermal researches on silicic ether, by M. Ogier. Its heat of formation may be determined either by analysis or by synthesis. The one method gave − 11·56 cal., the other − 11·44 cal.; mean − 11·5 cal. The heat of vaporisation of silicic ether is, for 1 equivalent, 7·0 cal.—Action of ammoniacal salts on some metallic sulphides, and application of the facts observed to mineral analysis, by M. De Clermont.—On a new mode of formation of glycocol by means of nitracetic ether, by M. De Forcrand.—On the production of conidia by a bacillus, by M. Engel. This was observed in June, 1876, when some of the numerous bacilli in the blood of a woman who had died in childbed were placed in Pasteur's nutritive liquor. M. Engel designated the bacillus as *puerperalis*.—Influence of heat on the functions of the nervous centres of the crayfish, by M. Richet. Either by asphyxia, or (better) by temperatures varying from 23° to 36°, one may paralyse separately the different functions of the ganglionic nerve centres; the voluntary, intellectual innervation disappears first at 23° to 26°; the reflex innervation, properly so-called, disappears at 27° to 29°; and lastly, the innervation of respiration disappears at 28° to 30°.—Regeneration of nerves of the anterior epithelium of the cornea, and theory of continuous development of the nervous system, by M. Ranvier. The regeneration of cells of the anterior corneal epithelium precedes that of the nerves, showing that the reproduction and nutrition of the epithelial covering of the cornea are independent of the nervous system. The last nervous ramifications tend by their nature to grow continually at the periphery.—On the respiratory apparatus of Ampullaria, by M. Jourdain.—On a new genus of Anouran Batrachian of Europe, by M. Lataste. This has been observed in Spain by M. Bosca. M. Lataste gives it the name *Ammoryctis*; it takes rank in the family of *Alytidæ*, of the sub-order of *Mediogyrinides*.—On the peculiar amyloid matter in the asci of some Pyrenomycetes, by M. Crié.—On the discovery of a jaw of Cainotherium in the gypsums of Aix (Bouches-du-Rhone), by M. Cairol. On borings made in view of formation of an interior sea in Algiers, by M. Roudaire. The new results are of the same order as the former.—Water-spouts at Vitry-sur-Seine, by M. Meunier.—M. Hervé Mangon presented the first volume of a "Statistical Atlas of Water-Courses, Manufactories, and Irrigations of France;" also a work by M. Demontzey, on the works of replanting and returfing mountains.

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