THURSDAY, MAY 12, 1881

THE LEPIDOPTERA OF SWITZERLAND

Die Lepidopteren der Schweiz. Von Prof. Dr. Heinrich Frey. 8vo. Pp. xxvi. and 454. (Leipzig: Engelmann, 1880.)

"IN the evening of a busy life I hand over for publication a book which, for a generation, has been suspended before my mind as an object to be attained. When in the summer of 1849, in the sunny days of youth, I, an indefatigable traveller, and passionate lover of *Lepidoptera*, for the first time traversed our glorious country in an extended sense, the idea of a Lepidopterous Fauna of Switzerland was conceived." In this manner the author (who is Professor of Pathology in the Polytechnic of Zürich) commences his introductory remarks. It may be well to state here that Dr. Frey is a Swiss only by adoption (we believe a native of Frankfort on the Main); and this will explain why it was not until 1849 that any extended journey in Switzerland had been made by him. His writings on Swiss *Lepidoptera* are familiar to all European students of the order. Many of these are monographic on special genera or groups, chiefly of the *Micro-Lepidoptera*, and in 1856 a volume of 430 pages—"Die Tineen und Pterophoriden der Schweiz" (a descriptive work)—appeared from his pen. To English readers his short, but very suggestive, paper on the "Tineæ of the Higher Alps," published in the *Entomologists' Annual* for 1858, can scarcely be forgotten. Now, "in the evening of life," as he terms it, he comes before the entomological public with his *magnum opus*. We heartily congratulate him thereupon.

It will readily be understood, from the fact of the work consisting only of one volume, and including therein *all* the Swiss species, that it is not descriptive, outside the very few new species or varieties mentioned in it. It is a carefully compiled catalogue, but very different from a bare dry list of names. To each species is appended a certain amount (not complete) of synonymy, indications of the food-plants of the larvæ, the time of appearance of the imago, and, what is most useful, a carefully analysed list of localities, with special regard to altitude, the latter being of great importance and value in treating of a fauna such as that of Switzerland. More than this, there are copious notes on the numerous varieties into which many species run, not only as concerns influences that locality may exercise in the country itself, but also in connection with the forms of the same species occurring in other parts of Europe.

Our author is strongly conservative in some of his views. He hesitates at species-splitting, unless there appear to be the strongest reasons for such a course. He almost snubs the innovations in Staudinger and Wocke's last European Catalogue (adopting however the sequence) by not accepting their changed nomenclature for the most part, but (for the sake of convenience and identification) placing the "restored" names between brackets.

We cannot presume to give an analysis of individual species and their distribution horizontally or vertically. This is everywhere carefully worked out, and more especially in the butterflies. 2508 species are recognised as Swiss, viz., 171 *Rhopalocera* (or butterflies), 61 *Sphingidæ*, 170 *Bombycidæ*, 439 *Noctuidæ*, 375 *Geometridæ*, 191 *Pyralidæ* and *Crambidæ*, 334 *Tortricidæ*, 727 *Tineina*, 35 *Pterophoridæ*, and 5 *Alucitæ*. If varieties (by some considered species) be added, the total is raised to 2829, the butterflies alone claiming 65 of these forms. In the higher groups the author has derived very great assistance from previous writers, or from the somewhat numerous collectors. But when we come to the *Tineina*, near the end of the work, all this is changed; whole pages, including many species on each, giving only one or two localities for each species, and "Frey" as the sole observer, a striking proof of the neglect under which those minute but intensely interesting forms suffer.

Switzerland attracts tourists from all parts of the world; many of these are entomologists who derive vastly increased pleasure and much profit by collecting insects; many of them publish accounts of the results of their excursions. We think the author might have added to his local information by consulting more of the scattered lists published by foreigners, and more especially many such that have of late appeared in English journals.

Very interesting are the copious introductory observations on the physical features of the country. A table gives thermometrical observations for twenty-six stations, showing a mean temperature ranging from + 12·58 Centigrade at Bellinzona (729 feet) to − 0·19 at the Julier Pass (7040 feet); of greatest cold from − 6·8 at Bellinzona to − 24·7 at Davos; of greatest heat from + 33·1 at Lugano to + 17·6 at the St. Bernhard Hospice. A copious analysis of the vertical range of vegetation, especially of certain trees, is given in connection with *Lepidoptera*. Conifers extend to over 7800 feet (it should be remembered that Paris feet are always intended; thus in English the heights would be seemingly greater) in the Southern Alps. At the Albula Pass (7120 feet) 152 species of *Lepidoptera* were noticed by the author, 44 of which were butterflies. About 8500 feet must be considered the limit for *Lepidoptera*, excluding occasional individuals carried higher by the winds. In a lengthened analysis the author does not lose sight of the probable origin of the Swiss fauna. Whilst showing indications of adoption of the glacial theory, he scarcely commits himself to an opinion, and prefers to give the facts, leaving it to others to build theories thereupon. A most instructive chapter is formed by an analysis of the following headings:—(1) species of the high Alps which occur unchanged in the high north and in other European mountain-ranges; (2) species which, living in the high Alps and the north, show but little change; (3) such as undergo greater change in the north and in other mountain-ranges outside Switzerland; (4) those that occur only in the Alps and in the Arctic Zone; (5) darker coloration in Alpine regions; (6) species introduced from the south. The introduction ends with five pages of about 470 Swiss localities, in double columns, with the altitudes.

The whole of this introductory portion cannot but prove fascinating to all who have visited the Alps, or have had occasion to study the insects of high latitudes. The time is fast approaching when multitudes of our countrymen will be spreading themselves over the length and breadth, or the height and depth, of Switzerland. Many of these will be naturalists more or less acquainted with the Alpine insect fauna. To those who have already made its intimate acquaintance and are competent to distinguish the majority of the species in the field, this work will prove invaluable for consultation on the spot; to those who leave the determination of their materials until arriving home it will add interest to a not otherwise always enjoyable occupation.

In these latter remarks we have endeavoured to make it attractive to the numerous naturalists who are more or less amateurs. But its claims for careful study by those who are working at geographical distribution as a special branch of science, and at the philosophical speculations that such studies give rise to, are indisputable, and cannot be neglected. R. McLACHLAN

WORKS OF JAMES MACCULLAGH

The Collected Works of James MacCullagh. Edited by Professors Jellett and Haughton. Dublin University Press Series. (Dublin: Hodges, Figgis, and Co.; London: Longmans, Green, and Co., 1880.)

THE admirable practice of building a monument to departed men of science from the original works they have left behind them is steadily gaining ground, and is now indeed almost the rule. The collected works of Green, Rankine, Wheatstone, Cavendish, Graham, and Clifford have been comparatively recently published; those of Maxwell are being edited.

When the papers republished have been written many years the judgment of editors must be severely exercised; the temptation to point out the relation of the work of the original author to subsequent discovery is great, but the difficulty of deciding how much to add is greater. The late Prof. Maxwell in his edition of Cavendish added much of his own, thereby increasing manyfold the value and interest of the book, and at the same time more clearly exhibiting the penetration and genius of Cavendish. In the volume before us little of annotation and nothing of criticism is added, the work is left to speak for itself.

Nearly two-thirds of the book is occupied by the first part, containing the papers on Physical Optics. These are twenty-three in number. The first four deal with the geometrical treatment of Fresnel's theory of biaxal crystals. Unfortunately MacCullagh failed to perceive, or at least to point out clearly, the remarkable experiment of conical refraction, so soon after predicted by Hamilton and verified experimentally by Lloyd.

The method of the sixth paper, on the "Laws of Reflection from Metals," is characteristic, as we find a somewhat similar treatment of the theory of transmission of light in quartz and to some extent in the dynamical theory of double refraction. There is no pretence to a firm foundation on mechanical principles. A formula is assumed, the physical meaning of which is not apparent, and the deductions from that formula are interpreted. Fresnel's formulæ for the intensities of the reflected and refracted rays in the case of an ordinary transparent medium are taken as a starting point. It is further assumed without attempt at physical interpretation that the velocity of propagation of waves in a metal is $m(\cos\chi + \sqrt{-1}\sin\chi)$. The real value of the method may perhaps be best shown by trying to interpret this apparently unmeaning assumption. Passing over the difficulties in Fresnel's method of interpreting $\sqrt{-1}$ as extended by MacCullagh, we have on the assumption of the paper—

$$\zeta = A\sin n\{x - tm(\cos\chi + \sqrt{-1}\sin\chi)\}$$

or which is equivalent—

$$\zeta = A\sin n\{x(\cos\chi - \sqrt{-1}\sin\chi) - mt\}$$

$$= A\{\cos\sqrt{-1}\,n\sin\chi x + \sqrt{-1}\sin\sqrt{-1}\,n\sin\chi x\}$$

$$\times\sin n\{x\cos\chi - mt\}$$

$$= A\,e^{-n\sin\chi . x}\sin n\{x\cos\chi - mt\}.$$

The physical meaning of this equation is obvious, it clearly means absorption in the metallic medium. MacCullagh's theory of metallic reflection would bear the same relation to a theory resting upon the fact of absorption in the metal that Fresnel's theory of total internal reflection does to Green's.

In the seventh paper, "On the Laws of the Double Refraction of Quartz," we find the same method of treatment. Without any reason of a mechanical nature two equations of motion are assumed, viz.:—

$$\left.\begin{aligned}\frac{d^2\zeta}{dt^2} &= A\frac{d^2\zeta}{dz^2} + C\frac{d^3\eta}{dz^3}\\ \frac{d^2\eta}{dt^2} &= B\frac{d^2\eta}{dz^2} - C\frac{d^3\zeta}{dz^3}\end{aligned}\right\}$$

and the integrals of these are shown to express experimental facts. Subsequently Maxwell has obtained for magnetic rotatory polarisation the equations—

$$\left\{\begin{aligned}\frac{d^2\zeta}{dt^2} &= A\frac{d^2\zeta}{dz^2} + C\frac{d^3\eta}{dz^2dt}\\ \frac{d^2\eta}{dt^2} &= A\frac{d^2\eta}{dz^2} - C\frac{d^3\zeta}{dz^2dt}\end{aligned}\right.$$

It is interesting to remark that each system is strictly appropriate to the case to which it is applied. MacCullagh's equations do not apply to magnetic rotation of the plane of polarisation, for there the direction of rotation is reversed if the ray be reversed. On the other hand Maxwell's equations are not to be applied to a solution of sugar or to quartz. The distinction has been overlooked by Verdet, who treats both sets of equations as appropriate empirical formulæ for magnetic rotation; it is perhaps not surprising that Maxwell's fitted those facts the best.

MacCullagh's fame as a physical optician rests mainly upon the well-known paper entitled "An Essay towards a Dynamical Theory of Crystalline Reflexion and Refraction." This is the fourteenth paper of the series. Its position, in relation to the theories of Green and Cauchy, has been very ably examined by Prof. Stokes (British Association Report, 1862). But the appearance of Maxwell's theory of the transmission of light leaves room for a reconsideration of Stokes's criticism. The real point of MacCullagh's position may be shortly stated. In order to obtain his differential equations he must ascertain the form of the function V which expresses the work done in causing a given deformation of the medium which transmits radiation. His reasoning is obscure, but it virtually amounts to this. Let $\xi\,\eta\,\zeta$ be the displacement at the point $x\,y\,z$ of the medium, and suppose a plane wave propagated through it. If under these *particular* circumstances the quantities—

$$\frac{d\zeta}{dy} - \frac{d\eta}{dz}, \ \frac{d\xi}{dz} - \frac{d\zeta}{dx}, \ \frac{d\eta}{dx} - \frac{d\xi}{dy},$$

are given at each point, these three quantities are in general sufficient to define the direction of the normal to the wave front and the direction of disturbance. Hence—and here is the fallacy—the *general* expression for V must be a function of these three quantities. MacCullagh was probably unaware that these three quantities simply defined the angles through which the element about the point xyz was rotated by the displacement. That his expression for the function V not only rests on wrong reasoning but is actually wrong, for the case in question, where V is supposed to depend upon *the change of form* of the elementary parallelepiped, is easily seen. Suppose the deformation to be irrotational: through a given space on MacCullagh's theory V vanishes: but we know it may be anything we please. Again, suppose the medium within a given space to be simply turned through a given angle without change of shape: MacCullagh gives a finite value to V: but we know that in this case V is zero. It is a pity that MacCullagh did not keep to the method of his papers on metallic reflection and on transmission in quartz, and simply say, without admitting that V depends on the change of form of the elementary parallelepiped, "let us assume that V is a quadratic function of $\left(\frac{d\zeta}{dy} - \frac{d\eta}{dz}\right)$, &c." His theory would then have had a certain amount of analytical similarity with Maxwell's theory of electromagnetic propagation of light, though giving not the slightest adumbration of the physical basis of that theory, the facts which it covers being almost unknown when MacCullagh wrote. MacCullagh's expression for V as a theory regarding the ether as an elastic solid is misleading, but we are certainly not compelled to be so materialistic. To the student of physical optics we should say, first read Green, then read and criticise MacCullagh and Cauchy, and finally read Maxwell, not once or twice only, but until you understand him.

OUR BOOK SHELF

On the Structure and Affinities of the Genus Monticulipora and its Sub-genera. By H. Alleyne Nicholson, M.D., D.Sc., &c., Professor of Natural History in the University of St. Andrews. Pp. 240, and vi. Plates. (Edinburgh and London: Blackwood and Sons, 1881.)

THIS is a most elaborate work, on one of the most puzzling groups of palæozoic fossils, by the accomplished and industrious Professor of Natural History at St. Andrews. He gives the general history and literature of the genus, describes the morphology, dealing carefully with the dimorphism of the corallum, treats of the development of the forms, and compares them with Heteropora amongst the Bryozoa. Then the affinities of Chætetes and Stenopora are considered, and those of the Helioporidæ also. A chapter is devoted to the sub-divisions of the genus and to the consideration of the propriety of separating from it Fistulipora, Coustellaria, and Dekayia. Finally five chapters are occupied by the consideration of as many sub-genera. Yet the author modestly says that it is not a monograph of the Monticuliporidæ! The book is particularly valuable on account of the mass of careful description it contains, and the plates and cuts are excellent, and everybody who has tried to make out these tubular fossils will be grateful to Prof. Nicholson for his work. Like most palæontologists, he has suffered from the fact that his predecessors have described genera and species from very imperfect specimens. This is the curse of modern palæontology, and a clean sweep should be made of every classification which is not clear and definite, and which was founded on bad specimens. The difficulty of the subject taken up by the author may be appreciated by noticing the synonymy of the species; and it is interesting to notice how recent investigations by Busk, Waters, and Moseley are influencing the palæontology of very remote ages.

The author states that in *Monticulipora* there are no septa, and the walls are imperforate, whilst in *Heteropora* the walls are traversed by a very remarkable and exceptionally developed canal system; hence he separates the groups, but states—"In the face of the above distinctions I feel compelled to believe, in the meanwhile, that there is no real relationship at all between *Heteropora* and *Monticulipora*." "On the other hand there are strong resemblances between *Monticulipora* and its allies and various undoubted corals—principally perhaps the *Helioporidæ*" "I am at present disposed to regard the *Monticuliporidæ* as ancient groups of the *Alcyonaria*."

P. M. D.

The Evolutionist at Large. By Grant Allen. (London: Chatto and Windus, 1881.)

WIDER and wider grows the field over which newspapers and magazines exert their distributive influence. Verily, they sow beside all waters, and great is the variety of the seed. Their readers find a royal road to learning the contents of books which they are too hurried to read in full, in short essays which collect the essence, omit the difficulties, and state the conclusions of the writers in the clearest and most unqualified terms. It is satisfactory to find that an effort is made to supply modern science to such readers from competent pens.

Mr. Grant Allen has collected into this engaging little volume a series of well-judged attempts to perform this which have appeared in the *St. James's Gazette*, and no reader who would consult that class of publication for scientific ideas could help being interested and, we should hope, led on to further inquiries by it. Mr. Allen describes himself fairly when he says (p. 109), "I am not a butterfly-hunter myself. I have not the heart to drive pins through the pretty creatures' downy bodies, or to stifle them with reeking chemicals; though I recognise the necessity for a hardened class who will perform that useful office on behalf of science and society, just as I recognise the necessity for slaughtermen and knackers. But I prefer, personally, to lie on the ground at my ease and learn as much about the insect nature as I can discover from simple inspection of the living subject as it flits airily from bunch to bunch of bright-coloured flowers." And any one who sympathises with such feelings will delight in the company of "The Evolutionist at Large."

Nearly all the fresh lights which have been thrown upon the relations of the natural world by the teachings of Darwin and Herbert Spencer are here condensed and exhibited in the most simple gossipping style; while it is hardly necessary to say that the most puzzling questions that remain unanswered will suggest themselves on many a page of such an author's book. His disquisitions on the extent of animal feeling (p. 50), upon the origin of two eyes and the cross-connection of them and other organs with the brain (p. 102), are very interesting. But the most striking question which time after time turns up, as we might expect in such a book by Mr. Grant Allen, is the origin of our æsthetic sense: and since the sense of beauty is little else than a feeling of harmony with and admiration for the forms, colours, and adornments of flowers and animals; and as these are all the result of their selection by animals in choosing their haunts and their mates, we are landed at the rather humiliating conclusion that a sense of the beautiful and an admiration for the forms and colours of nature is only a strongly developed instinct inherited from the lower animals! An uneasy feeling is raised not only that the rebuke administered to "man, the most conceited creature," by the flea in Gay's fable is well deserved, but that the description there given of the views taken by other members of creation are far more probable and even reasonable than ever their author thought.

It would very much help the less scientific public to accept the doctrine of development if by it any imaginable explanation of the part an insect takes in its own metamorphosis, or its feelings of personal identity through the states of grub, chrysalis, and butterfly, could be suggested; but an attempt explaining so little as chapter xv. must only make the incredulous close the book more sceptical still.

W. O.

An Elementary Course of Practical Physics. By A. M. Worthington, M.A., F.R.A.S., Assistant Master at Clifton College. 51 pp. (London: Rivingtons, 1881.)

THIS extremely useful and carefully prepared little book is intended to form the basis of the practical teaching of physics for schoolboys. It describes the way of performing fifty-eight experiments in elementary physical measurements. It appears therefore to have exactly struck the right line between the Scylla and the Charybdis of practical physics, in which a middle course between "merely qualitative work only leading to play" and "measurements by costly instruments requiring on an average two hours for each experiment," appears to be difficult to steer. Mr. Worthington, whose experience in teaching of this kind is considerable, has embodied the results of his labours in the present compendious little volume, and were the course he has sketched out adopted in all our public schools the gain to physical science would be great. There can be no doubt that one great drawback to the progress of students in physical laboratories even at the Universities is the want of acquaintance with the common instruments and with the principles of exact measurement. Mr. Worthington's course cannot fail to give this, and to teach moreover something of manipulation, exact observation, and of use of algebra and geometry as applied to real quantities. The acquiring of intelligent and orderly methods of recording observations is facilitated wherever possible by providing a blank schedule or form wherein to enter the various observations and their several corrections, and for comparison between the observed and computed results. The course comprises experiments in elementary mechanical measurements, centre of gravity, specific gravity, elasticity of cords, law of pendulum, &c., and also includes experiments upon the law of Boyle and upon the laws of expansion by heat and of specific heat. We trust it will not be long before Mr. Worthington adds a course of practical experiments in other branches of physics to the present series. He deserves the thanks of all who have to teach physics in the laboratory to beginners in manipulation.

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.*

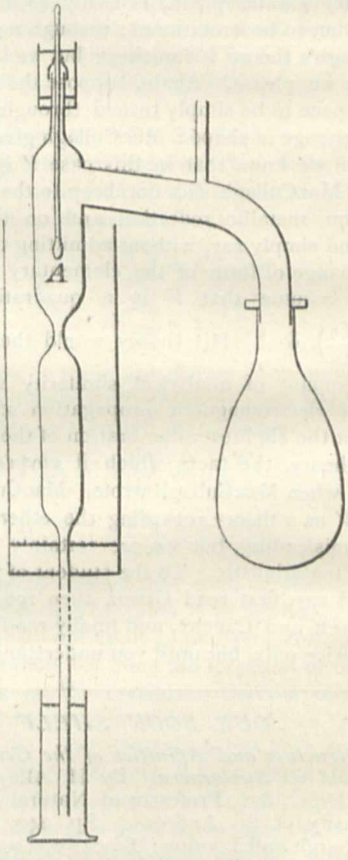
[*The Editor urgently requests correspondents to keep their letters as short as possible. The pressure on his space is so great that it is impossible otherwise to ensure the appearance even of communications containing interesting and novel facts.*]

Hot Ice

As my name has been mentioned in NATURE in connection with Dr. Carnelley's experiments on hot ice it may possibly be convenient if I describe the experiments in which I have failed to raise the temperature of ice and camphor above their fusing-points when they are heated *in vacuo*.

On December 16, I was present at the meeting of the Chemical Society, when Dr. Carnelley showed his experiments with ice, camphor, and mercuric chloride. At the time they did not appear conclusive to me, for it seemed (although in this I am possibly mistaken) that the thermometer bulbs were too close to the sides of the containing tubes, and that they consequently did not indicate the temperatures of the solids.

A few days afterwards I tried an experiment with camphor in an apparatus so arranged that the thermometer was held rigidly in the axis of a glass tube with the bulb in the middle of a block of camphor which had been previously melted in the tube. The apparatus was exhausted by a water air-pump, and the tube containing the camphor heated. No fusion took place, and the camphor volatilised rapidly; but the thermometer did not indicate a temperature as high as 157° C. The exact temperature could not be ascertained, for a part of the thermometer stem was hidden by the caoutchouc which connected it to the tube. The



fusing point of the camphor being 176°, it is certain that the temperature was far below this, although the glass tube was softened and there were indications of decomposition of the camphor vapour by contact with the hot glass.

Air was afterwards admitted, the camphor fused down, and the air exhausted until the liquid just solidified. Heat was then rapidly applied, but the temperature remained between 170°·2 and 172° until a portion of the thermometer bulb was exposed, when the temperature began to rise. Dr. Carnelley has since informed me that he has obtained precisely similar results with camphor.

On December 30 an experiment was tried with ice in an apparatus bearing a remarkable resemblance to one recently described by Prof. Lothar Meyer (*Ber. Deut. Chem. Ges.* xiv. 718, April 11). The tube A is surmounted by a narrower tube, in which the thermometer stem was fixed by a piece of caoutchouc tube, the joint being surrounded by a tube containing mercury. To the side of A a tube about half an inch in diameter, connected with a copper flask of half a litre capacity, is joined, a branch from this wide tube leading to a Sprengel pump. The tube A is narrowed in the middle, and its lower extremity terminates in a narrow tube about 33 inches long, and dipping into a cylinder of mercury. Some boiled water was introduced into A before the thermometer was attached, and a small quantity of water was placed in the copper flask. The air was then removed by the Sprengel, the exhaustion being facilitated by heating the copper flask. The water in the glass tube was also heated, in order to expel the dissolved air. When the exhaustion had been completed, the cylinder of mercury was raised until the mercury in the tube stood at the narrow part of A, and the cylinder surrounding the tube was filled with a freezing mixture of ice and salt, the copper flask being also placed in a similar mixture. When the water in the glass tube was solidified, the freezing mixture was removed from the cylinder, the latter lowered, and the column of mercury was depressed by lowering the cylinder of mercury until the column stood at the bottom of A.

A small gas flame was employed to warm the part of the tube containing the ice; some of the ice at the lower part of the solid plug melted and ran down to the surface of the mercury; the upper portion of the ice could not be fused in consequence of the diminished pressure on its surface. When the ice was completely detached from the glass tube a fresh quantity of freezing mixture was placed in the cylinder surrounding the lower part of A.

The air of the room was at 15° C., and the thermometer in the ice indicated − 8°. The tube A was now heated by a Bunsen burner, and the temperature shown by the thermometer was − 6°·5. A jet of steam from a test-tube with cork and narrow tube was directed against the side of A until the ice became very thin on one side of the thermometer bulb; the temperature was now − 1°. The freezing mixture surrounding the copper flask was nearly exhausted; it was therefore replaced by fresh ice and salt, and the steam once more directed against the tube. The thermometer now read − 5°·2. When a small part of the thermometer bulb was free from ice the jet of steam was stopped, and a new freezing mixture placed round the flask, the thermometer indicating − 6°·7. When about one-third of the bulb was exposed the tube was heated by a Bunsen flame and the temperature rose to + 4°, and on allowing the tube to cool it fell to − 5°. Finally, when only a very narrow strip of ice remained attached to one side of the bulb, the tube was strongly heated, and the temperature rose to + 12°, but on cooling it sank to − 2°·2.

The experiment was repeated on January 6, a jacket being placed round the tube so that the heating by steam was more regular than before. On first separating the ice from the containing tube the thermometer indicated − 8°. On heating with a Bunsen it rose to − 6°. When the tube was cold the temperature was − 14°. After passing a current of steam round the tube for half an hour the temperature was − 11°. A fresh freezing mixture was now used, and the steam again turned on; after twenty minutes a small portion of the thermometer bulb became exposed, and two minutes later the temperature was − 9°. A fresh freezing mixture was put round the flask, and when the outside of the tube was cold, the thermometer showed a temperature of − 16°. Steam was again turned on for fifteen minutes, when the temperature was − 12°. When the bulb was half exposed the steam jacket was removed, and the tube heated by a Bunsen; the temperature then rose to − 1°·5. On allowing it to cool it fell again to − 12°. When about three-quarters of the bulb was free from ice the tube was again heated by the gas flame, and the temperature rose to + 29°. The ice then fell off, and although the heating was discontinued the thermometer rose rapidly to 70°.

These experiments, as far as they go, are therefore in accordance with those of Mr. Hannay and Prof. Lothar Meyer, there being no considerable rise of temperature until either the condensation of the aqueous vapour was too slow and the vacuum thus deteriorated, or the thermometer bulb was partly uncovered, and so exposed to direct radiation from the walls of the outside tube.

Two experiments were tried with mercuric chloride, but the results were not satisfactory, in consequence of the high melting point of the solid. The temperature seemed to be above the fusing point, but it was found that the mercury in the thermometer stem had separated. HERBERT MCLEOD

Cooper's Hill, May 3

Sound of the Aurora

UNDER the above heading Mr. Ogle, in last week's NATURE (vol. xxiv. p. 5), gives an extract from the Visitors' Book at the Æggischorn Hotel describing certain electrical effects which were experienced by Mr. and Mrs. Spence Watson, Mr. Sowerby, and myself on July 10, 1863. I would add one or two facts with regard to our position and experiences. We reached the top of the Jungfrau Joch at 10.5 a.m., and were met by a violent hailstorm, which came rolling up from the northern side of the Col. We at once started to return, and had been walking for two hours down the centre of the Aletsch glacier when the electrical effects began to be felt; we reached the Mërjelen See at 3.15, so that at the time of the occurrence we had reached the lower part of the *névé* which is farthest from surrounding mountain tops, where the glacier is widest. We were enveloped in cloud, above which there were no doubt other clouds charged with electricity, and as they approached we were gradually being charged more and more strongly by induction from the lower cloud, and when the discharges or thunder occurred we were suddenly relieved by an electric shock. A kind of *brush discharge* of gradually increasing intensity went on for some minutes, followed by a sudden shock, and this process of bringing us up to the right state of excitement, to be relieved by a sudden shock, was repeated over and over again several times.

The hissing sounds were first heard in the alpenstocks, and gradually increased in loudness up to the sudden discharge. There were clear indications that as condensers of electricity we were not all of the same capacity. We were roped together in threes: in one set of three I was in the middle, with a guide in front and Mr. Sowerby behind. Whilst the charging was going on I felt the pricking sensation at the waist on the side where the cord was knotted, showing that those who were more influenced by electrical induction were charging the others through the rope which acted as a conductor. Judging by his actions, our guide (a young and active man) was strongly influenced by the charge, whilst Mr. Sowerby, the most staid and venerable of the party, was certainly influenced the least. In the other set of three the elderly J. M. Claret of Chamouni was least affected, whereas Mr. Watson, who was not the youngest of the party, was the most powerfully affected. These facts point to a direct relation between the temperament of the individual and his capacity for being excited electrically or his inductive capacity.

I should add that Mr. Packe has had similar experiences, but apparently to a less extent, in his walks in the Pyrenees.

W. GRYLLS ADAMS

Wheatstone Laboratory, King's College, May 9

Palæolithic Man

IN my communication to NATURE, vol. xxiii. p. 604, I chiefly restricted my notes to the higher gravels on the north side of the Thames in and near London. With your permission I will now briefly refer to some of the implementiferous gravels south of London, especially in Kent.

The best known of these are to be seen between the Reculvers and Herne Bay, where a thin stratum of implementiferous gravel caps the cliffs. Similar but deeper gravels, also bearing implements, occurs elsewhere inland, as at and near Chislet. At Canterbury a great number of implements have been found, and to these gravels and implements I would now direct attention. As a rule the Reculver instruments are sharp, unstained, and unabraded (such as have been rolled in the sea of course excepted); the Canterbury examples where the gravel is deep are found at various depths, from 9 feet to 20 feet.

Now there are two distinct classes of implements found in the Canterbury pits, the levels being, according to Dr. Evans, about 80 feet or 100 feet above the river: in one class the specimens are well made and almost as sharp and unstained as when first turned from the maker's hands, in the other the implements are much more rudely made, deeply stained all over of a dark ochreous brown colour, and abraded in a high degree. These latter implements come from distinct strata or deposits of ochreous brown rolled stones that appear to have been brought from a long distance. In my own collection of twenty-nine examples from Canterbury one half are sharp and bright, the other half greatly rolled and deep brown in colour. To my mind these two classes of instruments represent two totally distinct periods in the Palæolithic age immensely removed in time from each other, the abraded examples being the oldest. A point of importance to be observed in the deeply ochreous implements is that many of them were slightly splintered or broken when they were deposited in the Canterbury drift; now these broken and splintered parts are bright, lustrous, and non-ochreous, exactly resembling in the fractured parts the bright and unabraded implements. This fact appears to me to demonstrate that the abraded ochreous implements acquired their ochreous crust elsewhere, and were objects of great antiquity when the Canterbury gravels were laid down. I have one of these deep-brown greatly-rolled flint implements that was found amongst chert in the famous pit at Broom, near Exeter: the deep ochreous colour was not derived from chert gravel. From whence have these generally massive, abraded, ochreous implements been derived, and how laid down in distinct deposits?

As an instance of very high implementiferous gravels, the same distance south of London as the Ware gravels are north, the ancient gravels on the escarpment of the hills north of Sevenoaks and Ightham may be cited. Some of these heights exceed by 200 feet the heights of the Hertford and Ware positions.

Dr. John Evans, in his admirable book on the "Ancient Stone Implements of Great Britain," pp. 531-532, records the important discovery (on the surface) of ochreous and abraded implements at great heights near Currie Wood, a few miles south of St. Mary's Cray, Kent, at 300 feet above the valley of the Darent, and 500 feet above the sea. Dr. Evans also says (p. 531), "It is, however, necessary that further discoveries should be made in this district before it will be safe to speculate on the origin of these gravels and their relation to the superficial configuration of the neighbourhood." My friend, Mr. Benjamin Harrison of Ightham, has during the last year instituted a rigorous search over the high level gravels south of this district. A tributary of the Medway rises at Ightham, near Sevenoaks; the level of the present stream near the village is 254 feet, and an outlying bed of old river-gravel is found at 330 feet, and another bed up the stream at an altitude of from 380 feet to 400 feet. In these high-level Wealden gravels Mr. Harrison has recently found palæolithic implements *in great numbers*, generally massive, ochreous, and abraded. At 312 feet he has found them *in situ*, and on the surface as high as 335 feet. More recently Mr. Benjamin Harrison has examined the old river gravel at Dunk's Green (two miles and a half south of Ightham), and here at a level of 200 feet has proved the beds to be implementiferous. For these facts and heights I am indebted to Mr. Harrison, who has given me his permission for their publication.

In these two letters I have chiefly confined myself to statements of dry facts, purposely abstaining from any comments on the meaning of the heights, &c., referred to.

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Naval Cadet Examinations

I WISH to bring to your notice the injudicious severity to which our competitive examinations have of late attained, regardless, as it appears to me, of the possible injury they may inflict on the health of those who are forced to strain every power, both physical and mental, in the struggle.

The most recent example of the kind is, I believe, the New Standard for Naval Cadetships, which requires boys from between the ages of twelve and thirteen and a half to pass a competitive examination in Latin, French (both translating and speaking), arithmetic up to decimal fractions, algebra, including fractions and simple equations with one unknown quantity, geometry up to first twenty-six propositions of Euclid, English—with Scripture history. They are further tempted, if ambitious, to take algebra up to quadratic equations, and geometry up to the end of the first book of Euclid.

Now when the object to be obtained is no less than a career for life, one can imagine what a force of pressure—from the parent anxious to provide for his son, from the schoolmaster's pride in his pupil, and from the boy's own ambition—is brought to bear to urge nature to the utmost in the trial.

The casualties—for we are entitled to use the expression—that have already occurred under the system have been sufficiently numerous to make any one who will pause to think seriously anxious.

Education is most valuable, but when its attainment is at any time carried out at the expense of health to the pupil it is a failure. "Mens sana in corpore sano" is above everything to be prized, and he who enters upon life's work possessed of that advantage is fittest for its trials.

I will quote an extract from the *Lancet*, which treats the subject from a professional point of view and with an admirable clearness. It says:—

"There can be no room to question the extreme peril of 'over-work' to growing children and youths with *undeveloped* brains. The excessive use of an immature organ arrests its development by diverting the energy which should be appropriated to its growth, and consuming it in work. What happens to horses which are allowed to run races too early happens to boys and girls who are over-worked at school. The competitive system as applied to youths has produced a most ruinous effect on the mental constitution which this generation has to hand down to the next, and particularly the next-but-one ensuing. School-work should be purely and exclusively directed to development. "Cramming" the young for examination purposes is like compelling an infant in arms to sit up before the muscles of its back are strong enough to support it in the upright position, or to sustain the weight of its body on its legs by standing while as yet the limbs are unable to bear the burden imposed on them. A crooked spine or weak or contorted legs is the inevitable penalty of such folly. Another blunder is committed when one of the organs of the body—to wit, the brain—is worked at the expense of other parts of the organism, in face of the fact that the measure of general health is proportioned to the integrity of development and the functional activity of the body as a whole in the harmony of its component systems. No one organ can be developed at the expense of the rest without a corresponding weakening of the whole. These faults of 'training' attain their supreme height of folly and short-sightedness when they are committed in reference to the youths destined for the public services. They are especially illustrated by the 'Regulations respecting Naval Cadets' just issued, and which will take effect in June of the present year. The work of the Civil Service Commissioners in respect to these classes of the possible servants of the State is personally and racially *destructive*. Sooner or later public opinion must recognise this fact, and then perhaps the Government or the Legislature may be moved to interpose—not before, but when it is too late."

We live in an age of reactions, when ideas are hastily adopted, hurriedly brought into practice, and fanatically adhered to. I can only hope that public opinion will recognise the danger that the *Lancet* so clearly points out, and that the Government may interpose before it be "too late." J. D.

Flame-Length of Coal-Gas

I HAVE recently measured the flame-length of a sample of coal-gas burning in air and burning in nitrous oxide (N_2O). The flame-length in air was $\frac{13}{16}$ths of an inch and $\frac{5}{16}$ths in nitrous oxide. The relation of 5 to 13 is very close to what my theory would suggest, and is a confirmation of my law published in your issue of April 7.

I might add that I have recently noticed the flame of a mixture of hydrogen and nitrous oxide burning in air to develop a bright white spot about one-third from the top of the flame, and when the proportion of nitrous oxide is larger, to extend into a cone reaching to the jet. I have not examined this flame with a spectroscope, but am certain, from the whiteness of the flame, that the spectrum would be continuous. LEWIS T. WRIGHT

Water in Australia

A GENTLEMAN recently returned from Australia believes that the arid plain which occupies the centre of that island-continent might be amply supplied with water and converted into rich farm land by a very simple process. He founds his belief upon observed facts in the three sciences of botany, physiography, and geology, thus:—

1. Gum-trees and the mallee scrub flourish there. The gum-trees grow to a great size and withstand the drought of many summers. They must have water; whence do they obtain it?

2. Rivers which flow towards the centre from the mountain ranges along the coasts have no apparent outlet into the sea, but are lost in the desert. What becomes of them?

3. The underlying rock of the central plain is an almost horizontal bed of Tertiary Sandstone.

The conclusion is that the Sandstone is saturated with water and forms an immense reservoir from which existing trees draw their supplies by deep tap-roots, and that by sinking wells in the desert this water could easily be reached.

The author of this theory, wishing only to confer a public benefit, desires to bring it under the notice of scientific men, that it may be either turned to account or shown to be erroneous. If there is even a remote possibility of its truth it would seem worth while for one or more of the Colonial Governments to have borings made in order to test it. F. T. MOTT

Birstal Hill, Leicester, May 5

The Glacial Blocks of Zinal

MAY I through your columns express a hope that other qualified observers will volunteer to take charge of work such as I propose to do this summer as my share?

This is to mark the position of large blocks of stone on the glacier of Zinal. You will, I hope, receive the report of my friend, Prof. F. A. Forel, upon periodical variations of glaciers. Therein are sketched some of the existing data. I have for years much wished to organise a simultaneous action. With a Galton's pocket altazimuth, a pot of paint, and the superb map on the scale of $\frac{1}{50000}$ of the Swiss Alpine Club (Sheet III. of the Valais du Sud), it will be a pleasant and not a difficult task to lay down a few good triangles, and to paint a letter and indication of bearings of stones along and athwart the great glacier, with which I am well acquainted. The Swiss Alpine Club has erected a hut at Les Mountets, which, at about 9500 feet above sea-level, will form a capital base of operations. The pre-eminently grand scenery would itself reward the short sojourn necessary for our purpose. To secure uniformity of action and registration I propose that we should place ourselves in communication with M. F. A. Forel. [I shall be very glad to hear from gentlemen—at this address up to the end of June, and then at the Hôtel d'Anniviers, Vissoie sur Sierre, Canton Valais, the most comfortable quarters in the Val d'Anniviers, about 4000 feet above sea-level, three hours' and a half drive from Sierre railway station.

I would suggest, as good head-quarters and interesting fields of observation: (1) the hotel at the Riffelberg, with the Gorner and Findelen glaciers; (2) the hotel at Saas in Grund, with the Fée and other large glaciers in the Saas-Thal; (3) the hotel at the Maltmark See, with the Allalin and Schwartzberg glaciers; and (4) Macagnaga as a southern station. I myself, also, ask for personal assistance. MARSHALL HALL

Villa Chessex, Veytaux-Chillon, Canton Vaud,
Switzerland, May 3

THE FRENCH ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE AT ALGIERS[1]

III.

THE main result of the Algiers Congress has undoubtedly been the acquisition of a considerable amount of matter tending to the development of the great French colony, while at the same time it has been the means of making hundreds of Frenchmen well acquainted with the principal features—physical, geographical, and political—of a country which they knew previously only by name. The general results, as far as universal science is concerned, have been slight, but we cannot regard the Congress as less than a success. It is as if the French had said to the world of science, "Come and see this undeveloped country, and help us to apply each and all of the sciences to its special requirements, to aid us in a more perfect colonisation." The work has been nobly initiated by the French. It is probable that not less than a hundred millions sterling have been expended in the country. The roads and bridges, and telegraph and postal systems are perfect. Everywhere you find evidences of complete organisation. Every small village has its mayor and council; its post-office and diligence service; its water supply and sanitary arrangements; its groves of eucalyptus-trees and trimly-planted streets. Let us take one example—that of Bordj-Menaïel, a village to the east of Algiers, which we visited in the course of an excursion. Twenty-three years ago Bordj-Menaïel was made a centre of colonisation, and 1718 hectares of land were distributed among the first colonists. The total superficies of the commune is 4200 hectares, and it contains a population of 837, of whom 659 are Europeans and 178 indigenous races. Situated at a distance of 70 kilometres from Algiers and 38 from Dellys, it is traversed by the main departmental road passing to Eastern Algeria. It stands in the midst of a highly fertile alluvial plain, 28 metres above the sea, and is watered by the Isser. This commune possesses the following municipal officers: mayor, deputy-mayor, justice of the peace, sheriff's officer, receiver of "contributions diverses," a recorder of the census, a manager of ponts et chaussées, a departmental business agent, a bureau of posts and telegraphs, a "médécin de colonisation," a midwife, and a pharmacien. Its spiritual and intellectual wants are provided for by a *curé* and two schools. Since 1873 a brigade of gendarmerie has been stationed in the village. The organisation appears excessively elaborated for so small a population; but we must remember how doubly necessary such arrangements become in a new colony, which without sufficient proofs of the strong arm of the law would speedily become lawless, and without the benefit of well-directed and properly enforced municipal arrangements would form an ill-regulated and degenerating community. The bureaucracy evidently enters largely into the French system of colonisation.

At the present moment a project is before the Chamber for the completion of the colonisation of Algeria by the creation of 300 new villages, which, like Bordj-Menaïel and the existing villages, are to be built and thoroughly organised before colonists are invited to accept the grant of land in the commune and take up their abode in the village. Such of the existing villages as we saw were of one and the same type: the church and water-supply in a central square, from which two or more streets proceeded; the mairie, a few shops, one or more inns, and a post-office. In some villages—Palestro, for example, many of the inhabitants of which were massacred by the Kabyles so recently as 1871—there was a large space, surrounded by a high wall furnished with loopholes, in which the inhabitants could take refuge in the event of a sudden descent of the natives. Many of the colonists are Alsatians or Lorrainers who emigrated at the close of the Franco-Prussian war. They all appeared happy and contented, and their farms and gardens were flourishing. Their worst enemies are drought and fever; the former is being provided against by new systems of irrigation, and the latter by the planting of thousands of eucalyptus-trees. At Blidah we found a perfect example of the most developed system of irrigation. A ready supply of water is obtained during many months of the year from the mountains, and this is led by small brick-lined watercourses through the gardens. A main watercourse passes a line of houses, the garden walls of which are furnished with small trap-doors by which at any time a portion of the stream can be diverted into the garden. Of course rain is always looked for with great anxiety, specially between the months of May and September, when the grain crops are wholly dependent upon it. In the south of Algeria there exist at this moment places where no rain has fallen for *six years*, and of course any attempt at cultivation is here impossible.

Towards the end of the Congress several of the sections showed greater vitality than at the commencement. In the section of Mathematics there was for the first time a fair show of papers, for the most part devoted to pure geometry. The foreign mathematicians—Leguine of Odessa, Oltramare of Geneva, and Fiedler of Zürich—contributed their quota. M. Trépied brought forward a project for the construction of an observatory at Algiers. M. Picquet has been elected president of this section for next year. In the section devoted to Civil Engineering the most important papers were by Col. Fourchault on defensive villages, and by M. Trémaux on irrigation. M. Gobin is president for next year. In the Physical section papers were read by M. Gaussen on photometric photography, and by Prof. Tacchini on the solar protuberances.

[1] Continued from vol. xxiii p. 607.

There was no paper of special interest in the Chemical section, of which M. Grimaux is president for 1882. The section of Meteorology was very active at the last, and supplied some interesting papers on the meteorology of Asia, of the Sahara, and of the district between the Atlas and the Cevennes; also on meteorological instruments—thermographs and anemographs, and registering barometers. MM. Denza and Tacchini among the foreigners contributed largely to this section. M. Fines is the president for 1882. The Geological section had no communications of general or special interest. Professors von Szabo of Buda-Pesth and Villanova of Madrid both contributed papers, and an interesting communication was made by M. Fusch (who is president of the section next year), on the lead and iron mines of Tunis, and the copper mines of the Petite Kabylie, a district to the east of Algiers. The Botanical section announced only two papers of very limited interest for the last day but one of the Congress, and it did not meet at all on the last day. M. Ed. Bureau is president for 1882. The sections of Zoology and Zootechny also showed signs of languishing. On the other hand the section of Anthropology exhibited the greatest vigour from first to last, and on the last day of the Congress no less than sixteen papers, many of them of great local interest, were announced. Among these we may specially mention observations on the Kabyles of the Djurdjura, and on the Tziganes; on the Romans in Africa, and the Berber migration; on the civil, political, and religious institutions of the Jews; and on craniometrical studies in the oasis of Biskra. A prehistoric map of the north of Africa was discussed by M. Cartailhac. Anthropology is one of the sciences which has benefited most by the Algerian Congress. M. Henri Martin is president for 1882.

The interest in the Medical section continued to the last. We have before had occasion to remark that the Congress to a great extent was a medical *réunion*, and more than one-fourth of the members were medical men. Seventeen papers were announced for the last day of the session, and fourteen had been read the day before. The most interesting to the general non-medical members were on the epidemics of Algiers, on acclimatisation, and on the climate of Algiers as regards its influence on consumptive patients. Dr. Azam of Bordeaux is the president for 1882. The success of this section has been complete; a large number of very valuable papers have been communicated, and the attendance has always been large. The final papers communicated to the section of Agronomy related mainly to the development of the agriculture of Algiers: on the cultivation of cereals and of sorghum; on the rearing of cattle; on agricultural railways; and on watercourses. M. Dubort is president for 1882. The section of Geography was also mainly devoted to Algerian questions: the Trans-Saharian Railway; the geodesy and topography of North Africa; maps and geographical vocabulary. The section of Political Economy devoted its last hours to the dominant subject throughout—the colonisation of Algeria, the treatment of the indigenous races, and the peopling of the Sahara. Finally the section of Pedagogy visited the principal schools of the city, and collected as much information as possible concerning the methods of instruction.

At the commencement of the Congress the members were presented with a volume entitled "Notices Scientifiques, Historiques, et Économiques sur Alger et l'Algérie." The second volume is to be ready before the end of this month. The work is compiled by twenty-one residents in Algeria, each one very competent to discuss the subject of his contribution. Thus the geography is described by the president of the Algerian Geographical Society, the general administration by the secretary of the Council of Government, and the history by the Director of the École supérieure des Lettres. The whole constitutes the most complete and exhaustive history of Algeria which exists. Starting with the geography, hydrography, and climatology of the country, an able discussion of its complex meteorology follows. Statistics are given of the barometric pressure, mean temperature, hygrometry, winds and atmospheric currents, electricity, rain, evaporation, &c. There are forty meteorological stations in the country, extending from Mogador in Marocco, to Sfax in Tunis. A daily bulletin has been issued since 1875, and it is distributed over thirteen points on the coast. The very interesting geology and mineralogy of the country forms an article by M. Pomel, from which we learn that copper, argentiferous lead, zinc, iron, building-stones, and salt are profitably mined. About 3500 miners are employed, more than half of them finding occupation in the province of Constantine. The succeeding articles treat of botany, zoology, and anthropology. The major part of the indigenous population consists of two ethnic groups: on the one hand the Arabs, nomad tribes, shepherds, with a patriarchal organisation, and with warlike and religious feudality (*féodalité guerrière et féodalité religieuse*); on the other the Kabyles, cultivators of the soil, non-nomadic, and with a social organisation which is democratic and communalistic.

An article of much interest, by Dr. Liautaud, treats of the colonisation and peopling of Algeria. We have no space to give even an outline of its contents, but we commend it to every one interested in the present and future of the colony. It is followed by articles on the actual state of agriculture; industry and commerce, public works, the financial system, and the Algerian budgets. Then a general survey of the history of Northern Africa is given by M. Masqueray; archæology by M. MacCarthy; the general administration by M. Dimier; judicial organisation by M. Fau, Advocate-General of Algiers, and taxes and imposts by M. D'Aufresne.

We will glance for a moment at some of the statistics connected with public works and education. When the French took possession of Algiers in 1838 they found a *tabula rasa* as regards public works. In 1843 they set on foot the drainage of the Mitidja; between 1840 and 1846 ports were constructed, and lighthouses placed along the coast, and great systems of excellent roads were inaugurated; in 1857 railways were commenced. Forty-five lighthouses are now in operation, and there are seven ports. In 1830 the imports amounted to a value of 5,000,000 francs, and the exports to 1,500,000 francs; while in 1879 the values were respectively 272,126,102 francs and 151,918,421 francs. There are 10,506 kilometres of roads and 1282 kilometres of railways. There are now about 600 agricultural villages dispersed through the three provinces of Algiers, Oran, and Constantine.

As regards public instruction, higher instruction is given in four schools, which no doubt will soon be united into a university: law, medicine, letters, and science. Secondary education is provided by a Lycée in Algiers, ten communal schools, and three free schools. The former contain 3405 pupils, among whom there are 365 Jews, and 272 Mussulmans. The number of primary schools, including Arabic, Kabylic, and Arab-French schools is 703, in which are educated no less than 53,803 pupils—28,803 boys, and 24,501 girls. The boys consist of 11,639 French, 7336 foreigners, 7408 Jews, and 2420 Mussulmans.

On April 20 the various excursions commenced: eastward to the confines of Tunis, southward to the Sahara, and westward to the boundaries of Marocco. We have not space to tell how we went into the country of the *indigènes*—the Kabyles who were driven into the mountains when the Arabs first took possession of the land—how they met us headed by their chiefs, and conducted us, with accompaniments of barbaric music, and discharges of guns to awaken the echoes, through the magnificent gorges of Palestro; and how on the following morning we breakfasted with them in one of the most picturesque spots imaginable, and finally how we realised with difficulty that we were only four days' journey from London, while breakfasting, under a bower of carouba branches, off sheep roasted whole over hot ashes placed in holes in the earth, manipulated with hunting-knives and without forks, flat circular cakes of Kabyle bread serving us for plates, and gigantic wooden bowls of *kous-kous* as a second course.

The amicable attitude of these once savage aborigines seemed to us to re-echo the key-note of the Algiers meeting of the French Association; to proclaim loudly and with no uncertain sound that the "conquête pacifique de l'Afrique septentrionale par les Français" has indeed become an accomplished fact. G. F. RODWELL

ELECTRIC LIGHTING[1]

II.

THE second district of the City which has been illuminated by electricity is that embracing Blackfriars Bridge, upon which there are seven lamps; Bridge Street, in which there are four lamps, Ludgate Circus taking three lamps; Ludgate Hill four lamps; north side of St. Paul's six lamps; and Cheapside, as far as King Street, eight lamps; thirty-two lamps in all, replacing 150 gas lamps; and moreover, all these lamps are fixed upon one circuit, which is operated practically by only one machine, and that fixed more than a mile away, at the manufactory of the Brush Company in York Road, Lambeth. The total length of this circuit is over 20,000 feet. It consists of a copper cable made up of seven best copper wires surrounded with a thick layer of gutta-percha protected externally with tape that has been well tarred. This wire gives a total resistance of 7·5 ohms., and is protected by iron pipes like the Siemens method, and laid on the principle so well known in telegraphy. The dynamo-machine is of the familiar Brush form, and at present there are two machines of the size known as No. 7 cabled up in series, but forming practically only one machine. These two machines are intended to be replaced by one dynamo-machine, which, at a velocity of 800 revolutions, and worked by 32 indicated horse-power, will maintain forty lamps burning. The main feature of the Brush system is its simplicity, one machine working a number of lights, and those who visit the engine-room of Messrs. Siemens, and then that of the Brush Company, cannot help being struck by the immense difference in the contrast between the two. In Siemens' engine-room one feels in the midst of a whirling cotton manufactory; at the Brush works one sees nothing but a single engine working a single machine quietly and without fuss or flurry.

At present a Galloway engine is used by the Brush Company, but when the large 40-light dynamo-machine is set to work a Brotherhood 3-cylinder engine of 32-horse power will be used. These engines are admirably adapted for electric light purposes; they are bolted on to the same frame as the dynamo-machine, and give a compactness and solidity to the whole that is very striking.

The Brush lamps differ but very little from the generality of arc lamps. The carbons are maintained apart by what is known as a "sucking" coil; and the lamp possesses one or two very ingenious designs to shunt it out of circuit when anything fails and to shunt it in when all is in order. It is a kind of duplex lamp, supplied with a double set of carbons, each of which burns for eight hours, the total illuminating durability of the lamp being therefore sixteen hours. These lamps are fixed upon the ordinary lamp-posts, which have been raised 2½ feet higher than usual, so as to maintain the lamp 16 feet from the ground. They are surmounted by very ugly roofs that are neither covers nor reflectors, and the mode in which these lamp-posts have been utilised is the least commendable feature of this system. Indeed the Company might have made much more of their facilities. Compared with the tall posts in the remainder of Cheapside they make an unfavourable impression. The globes that embrace the light are too small, and the Company itself seems not to have arrived at the proper decision as to the best quality of globe to use, for in some places the lamps have clear globes, in others ground-glass, and in others opal globes, made, we believe, by Mr. Frederick Siemens of Dresden.

It cannot be said that the mode of illumination adopted by the Brush Company is perfect at present. The theory of the proper distribution of the light has been neglected. The lamps are scattered about in an irregular manner that is quite offensive to the eye, and though the effect of each lamp is certainly brilliant, the effect of the whole is rather displeasing. It is very wonderful that so much light should be produced from a point so far, and there is no doubt that the public mind has been captivated by the brilliancy of the lamps. The scientific eye however sees room for improvement, and it is hoped for the sake of the success of the experiment that the Brush Company will be guided by the experience of disinterested persons. The great merit of their system is the simplicity of the machinery employed, as well as the brilliancy of the light, but occasionally the lights are subject to great want of steadiness, and it is much feared, with the quality of the cable they have used and the enormous electromotive force, that the usual faults accompanying underground wires will develop themselves rather largely. In fact, two very serious breaks-down have already occurred, and they are about to replace their conductor by a better one. They will have to pay dearly for their neglect of common experience.

So far the experiment has shown that the practical lighting of streets by electricity is not only feasible but practicable. Moonlight has certainly been thrown into the shade, for the streets of the City are better illuminated by electricity than by fair Luna. It is quite possible to read a letter or to see one's watch at any point in King William Street. Indeed the smallest object can be seen anywhere, even in the middle of the road. Running-over has been rendered impossible.

The outside districts not specially favoured are clammering for electric lighting, but much has yet to be learnt before the experiment can be determined as final. For instance, we have the Lontin system to be tried, and we should certainly like to see that most energetic and successful engineer, Mr. Crompton, test his system in the London streets. Incandescent lamps are looking up and deserve a trial.

The best mode of distributing light has not yet been settled.

It would seem that a compromise between the centralised system of Siemens and the distributed system of the Brush Company is that needed to solve the problem of proper street illumination. But instead of carrying lamps irregularly down streets on hideous lamp-posts it would almost seem that the ancient defunct mode of swinging lamps across streets from housetops would be a better mode of illuminating streets. Take, for instance, Regent Street. If that street had suspended above it, at the height of 40 feet or 50 feet and at about every 100 yards, a Brush lamp fitted on the top of a graceful iron arch, or suspended on wire ropes between the tops of the houses, nothing could possibly be greater than the effect. Light arches thrown across the street might even be a convenient mode of suspending the wires forming the circuits, for overhead wires have a considerable advantage over underground wires in this, that they cool more rapidly and allow more electricity in consequence to pass through. More than that, they require no insulation, and the money thrown into their insulation could be thrown

[1] Continued from p. 7.

into their greater mass and greater strength. We illustrate this idea in Fig. 1. The City of London authorities who have shown so much energy and commendable zeal in carrying out this experiment would still further confer a favour on the public if they were to remove their hideous heraldric excrescence on the top of the so-called Temple Bar Memorial, and replace it by a handsome bronze pillar 30 feet or 40 feet high carrying a bright and brilliant electric light.

The Siemens system compares favourably with the Brush system in one respect, and that is they do not throw all their eggs into one basket. In their distributed system they have arranged the lamps on two circuits, so that each alternate lamp is on a different wire, and if anything goes wrong with the one circuit only alternative lamps go out, and not all. With the Brush system, on the contrary, if any fault occur in the wire in any of its length of nearly two miles, then every lamp on that circuit must go out.

The effect of fogs upon this system will be narrowly watched. It may happen, and probably will, that the fogs will be absolutely utilised by the electric light, for the reflection in the neighbourhood of the light by the small particles that constitute the fog throwing back the rays of light will help to illuminate the street, and so to a considerable extent relieve the impression now produced by dark fogs.

Of the efficiency of the system, as we have said, there can be no doubt. As to its economy, experience alone can determine. That the firms themselves require experience on this point is evident from the disparity in the charges made by the two firms competing. The Brush Company only estimate the cost of working their system at 660*l*., which is the cost of gas: Siemens Brothers estimate the cost of working at 2270*l*., nearly four times the cost of the Brush. We are inclined to think that a mean must be taken between these two. It is hopeless to expect that electric lighting in every case can be done at the cost of gas. Electric lighting is a luxury, and as a luxury we must expect to pay for it. Nevertheless it must not be forgotten that gas utilised as a motor can produce eleven times the quantity of light by the aid of electricity than it produces by direct combustion. This calculation is interesting. One hundred cubic feet of gas per hour can be made by combustion to produce 300 candle-power. The same quantity of gas used in a gas-engine to rotate a dynamo-machine will produce a light equal to 3750 candles, an illuminating power twelve times greater. Hence there must also be some cases in which the electric light can economically supplant gas; whether it can do so in the case of street-lighting remains to be seen by the great experiment now being tried.

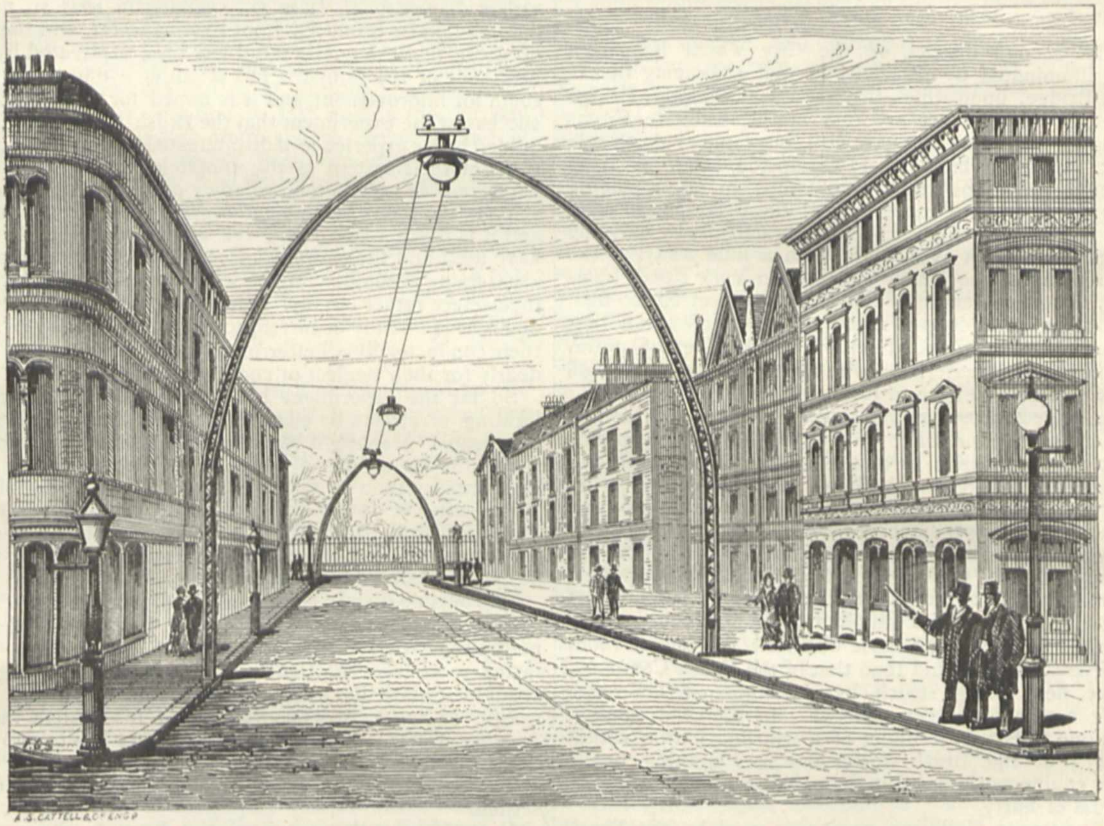

Fig. 1.

There are two or three very interesting points on the line of illumination where comparisons can be made between the different systems. For instance, from the middle of Blackfriars Bridge there is a good comparative test between the Brush and Jablochkoff systems; while at the corner of King Street there is an equally excellent opportunity to examine the merits of the Siemens distributed and the Brush systems. Photometric measurements at each place prove that the Brush Company's estimate of the light power of their lamps is absurdly exaggerated; 750 candles would be a very fair figure to give the lamp. The unhesitating opinion is that comparing each individual lamp, the Brush surpasses the others. In fact there is little difference between the smaller light of Siemens and the Jablochkoff, excepting this, that the Jablochkoff, by its variation and pinkish effects, irritates the eye considerably, although in bright weather the effect on the water is sparkling and brilliant. The Jablochkoff system has been entirely put in the shade by this interesting experiment. Though however we are obliged to express our opinion that the Brush lamp, *per se*, is the best, their system of illumination and distribution of posts cannot be compared with the care and skill evinced by the Messrs. Siemens. If either company were to try our suggestion, and illuminate down the centre of the street, maintaining the line of the street in their line of lights, we should have another interesting experiment that would go far to solve this question.

One last point deserves attention. It is the effect which these strong and powerful electric light currents have on the working of the telegraph. It was feared that their presence would deteriorate the working capacity of telegraph wires, and undoubtedly it would be so were it not that, taking advantage of the warnings given them, the electric light people have in all cases adopted a *return* wire, so as to make their circuit completely metallic throughout. We are glad to learn that this has proved quite effective except in one instance, where along London Bridge the return wire has been taken round the other side of the bridge, and here considerable disturbances have been experienced in certain telephone circuits from the contiguity of the electric light currents. No other disturbance has as yet been experienced.

We have also as yet to experience the effect of weather. Up to the present moment it has been all in favour of the electric light—bright, clear, cheerful skies have given to the light a clearness and brilliancy that have created for it a strong feeling. When thick weather and rain and fog occur there may be a change in this opinion, not only from a disturbance of the penetrating power of the light, but on the effect of rain and moisture on the wires conveying the currents.

(*To be continued.*)

DR. HOLUB'S AFRICAN TRAVELS[1]

I.

FROM his boyhood days Emil Holub determined he would explore some of the out-of-the-way portions of the African continent, and in 1872 the opportunity was presented to him of travelling in the southern parts of that great and still unexplored country. The result of seven years labour, during which period of time he made three several journeys of investigation, are now in these volumes laid before the public. In Dr. Holub's first journey he started from Port Elizabeth, crossing the Cape Colony district and the extreme south-west corner of the Orange Free State, to Kimberley. As far as Grahamstown he could have had the modern convenience of a train, but preferred a two-wheeled cart drawn by four small horses, making about eight miles an hour. The country is very charming for the greater part of this route, the road being beneath the brow of the Zuur Mountains, which with their wooded clefts and valleys, and their little lakes inclosed by sloping pastures, afforded many interesting views. The fauna was as varied as the flora, and numerous captures were made by the way. Even large game like elephants were to be met with, and the author records a sad accident which happened in the underwood by the Zondago River, between Port Elizabeth and Grahamstown. A black servant sent to look for some strayed cattle had been met by a herd of passing elephants, some of whom knocked him down and then trampled him to death. In this district these big animals are under the protection of the Government, and not being often interfered with, they would seem to have no great fear of man. The springbok (*Antelope euchore*) is noticed as still in some districts swarming, though its numbers must be rapidly diminishing, as Dr. Holub saw whole waggon-loads brought to Kimberley, where the carcases were sold at prices varying from three to seven shillings a head. Among other wonderful instances given of the great skill of the Dutch Boers in bringing down these swift creatures, he tells of one expert marksman killing by a single shot from his breech-loading rifle two of these antelopes.

Towards Colesberg the country forms a high tableland ; it is on an affluent of the Orange River. On this table-land there was a herd of upwards of fifty quaggas, the only herd the author could hear of in South Africa. The farmers have lately spared them, so that during the last ten years they had increased to their present number from a small herd of fifteen. Philippolis, the first town entered of the Orange Free State, is described as dreary-looking, the houses mostly unoccupied, and the general aspect most melancholy. On the way to the Diamond Fields nothing but bad roads and worse weather were encountered; the wind was piercing, and snow actually fell. Fauresmith, one of the most considerable towns in the republic, although consisting of not more than eighty houses, covered a considerable area. It was clean and pleasant-looking, and here the author thought of settling for a time, and by the practice of his profession saving enough of money to enable him to start afresh for other fields ; but the fates were against him, and he was, after a few days, obliged to push on to the Diamond Fields, and the following extract will best tell of these :—

"The first day upon which I set my eyes upon the Diamond Fields will ever be engraved on my memory. As our vehicle made its rapid descent from the heights near Scholze's Farm, and when my companion, pointing out to me the bare plains just ahead, told me that there lay my future home, my heart sank within me. A dull dense fog was all I could distinguish. A bitter wind rushing from the hills, and howling around us in the exposure of our open waggon, seemed to mock at the protection of our outside coats, and seemed resolved to make us know how ungenial the temperature of winter in South Africa could be ; and the grey clouds that obscured the sky shadowed the entire landscape with an aspect of the deepest melancholy. Yes ; here I was approaching the Eldorado of the thousands of all nations, attracted hither by the hope of rich reward ; but the nearer I came the more my spirit failed me, and I was conscious of a sickening depression. Immediate contact with the fog that had been observed from the distant heights at once revealed its true origin and character. It proved to be dense clouds of dust first raised by the west wind from the orange-coloured sand on the plains, and then mingled with the loose particles of calciferous earth piled up in heaps amidst the huts on the diggings. So completely did it fill the atmosphere that it would require little stretch of imagination to fancy that it was a sand-storm of the Sahara. As we entered the encampment the blinding dust was so thick that we could only see a few yards before us ; we were obliged to proceed very cautiously, and before we reached the office of the friend I had to call on, another mile or so farther on, our faces and our clothes were literally incrusted. We only shared the fate of all new-comers in feeling not only distressed but really ill ; the very horses sneezed and snorted, and showed that the condition of things was no less painful to them than to their masters. Here and there on both sides, right and left, wherever the gloom would permit me to see, I noticed round and oblong tents and huts intended for shops, but now closed, built of corrugated iron. Under the fury of the wind the tent-poles bent, and the ropes were subjected to so great a strain that the erections threatened every moment to collapse. Many and many a sheet of the galvanised iron got loose from the roofs or sides of the huts, and creaking in melancholy discord, contributed as it were to the gloominess of

[1] "Seven Years in South Africa. Travels, Researches, and Hunting Adventures between the Diamond Fields and the Zambesi." By Dr. Emil Holub (translated by Ellen E. Frewer). With about 200 original illustrations and a map. In two volumes. (London: Sampson Low, Marston, Searle, and Rivington, 1881.)

the surroundings. In many places too the pegs that had fastened the tents to the ground had yielded to the pressure, and sheets of canvas were flapping in the air like flags of distress. Truly it was a dreary scene, and I sighed at my dreary prospect."

Here Dr. Holub spent some months, making but one excursion at Christmas time (1872) just within the border of the Free State, to enjoy a little fresh air and have a shot at the baboons. In this portion of his work he gives a very interesting account of the diamond workings at Kimberley, and of the motley crew of workers that he met. Some views of the Kimberley Kopje as it appeared in 1871 are given, one of which (Fig. 1) will give our readers some idea of the dreary aspect of a "diamond quarry." His medical practice increased so rapidly that by the end of January, 1873, he was enabled to purchase a waggon and a good many of the requisites for travel, and early in February he actually started out on his first long journey of exploration, which, however, he from the first only regarded as one of reconnaissance, with the object of getting in part acclimatised to live in the open air, and to acquire by actual experience a knowledge of what would be necessary for a prolonged journey into the interior.

Fig. 1.

The first village passed through was Pniel, a German missionary station among the Koranna. With the exception perhaps of the Matabele, no native tribe appeared to have been so little influenced by missionary labour. Their culture is of the very lowest grade. Of all the South African races the Koranna bestow the least labour upon the structure and the least care upon the internal arrangements of their dwellings. Their huts (Fig. 2) consist of a bundle of branches about six feet in length, the upper ends tied together, the lower arranged in a circle, some rush-mats thrown over this hasty framework, in which an aperture is left large enough to admit a human being on all fours. A hollow dug out in the centre is the only fireplace. Scarcely anything worthy of the name of agriculture is carried on, and their chief care is devoted to their corn and goats. Lazy, dirty, untruthful, living without a thought beyond the present, capable of any crime for the sake of drink, it seems no great pity that the tribe is dying out. Crossing the Vaal River, Klipdrift was reached; in the district between the Vaal and Harts Rivers herds of the striped grey gnu (*Catoblepas gorgon*) were to be seen. The roads were here no better than the channels of boulder streams. Formerly both shores of the lower part of the Harts River were in the possession of Yantje, the Batlapin chief, who is a dependant of the British with an income of 200*l*. a year. This chief now resides at Likatlong. The Batlapins are mostly of middle height, not so tall as the Zulus nor so powerfully built as the Fingos. Their complexions are bright and clear; they have very wide noses.

The sugar-cane was cultivated here and there, but the only use made of it was the chewing the more juicy portions of the stem. After Klipdrift, Bloemhof was visited; then the Maquassie River was crossed, and a few days were spent at Klipspruit, which would seem to be quite a paradise for the sportsman; the early morning hours never failed to exhibit many herds of gnus and antelopes. The bushes were the haunt of the guinea fowl. This breed of wild fowl is one of great interest; though hunted perpetually, it would appear to be still on the increase; most frequently it is found in flocks of from ten to forty in number.

Arriving at Wonderfontein, the underground fissures, sometimes several miles long, were examined. One fine cave, known as the "Grotto of Wonderfontein," was partially explored; a little brook rippled through it, and it was thickly inhabited by bats. After much enjoyment of the natural objects associated with this place, Dr. Holub determined to end here his first excursion, and from thence to make his way back to Dutoitspan; slightly altering his track back, he broke somewhat new ground. Here is a short account of an encounter with a mass of feathered life :—

"The bank on which we crouched was the boundary of a depression overgrown with grass and reeds, but now full of rain-water. In this pool were birds congregated in numbers almost beyond what could be conceived — birds swimming, birds diving, birds wading. Perhaps the most conspicuous were the sacred ibises, of which there would not have been less than fifty, some of them standing asleep with their heads under their wings, some of them striding about solemnly, pausing every now and then to make a snap at a smaller victim, and some of them hurrying to and fro, dipping their bills below the water in search of fish. On the far side, as if utterly oblivious of the world, a pair of grey herons stood pensive and motionless. From amongst the weeds, rose the unabated cackle of wild ducks, grey and speckled. Mingling with this were the deep notes of the countless moorhens, while an aspect of perpetual activity was given to the pond by the nimble movements of swarms of little divers. At a spot where the bank descended somewhat sharply to the edge of the pool several ruffs were wandering backwards and forwards, uttering their peculiar shrill whistle, and large flocks of sandpipers were to be noticed, either skimming from margin to margin of the water or resting passively just where they had alighted. The explanation of this enormous concourse of the feathered tribe was very simple. A storm of unwonted violence had washed down from the plain above into the hollow beneath myriads of worms, insects, lizards, and even mice, and so bountiful a banquet had attracted the promiscuous and immense gathering which had excited my wonder."

The second excursion was begun under somewhat better auspices, but it was only contemplated to journey over half the distance between the Diamond Fields and the Zambesi. The expedition started in November, 1873, with four Europeans, a waggon and eight oxen, with a Griqua driver, a saddle-horse, and nine dogs. From Dutoitspan it first went to Musemanyana, which is the most northerly possession of the Koranna king of Mamusa. On the north and east it is bounded by plains abounding in game, to which the author gave the name of the "Quagga flats." They belong to Montsua, and are the common hunting grounds of Batlapins, Barolongs, Korannas, and the Dutch farmers from the Western Transvaal. From Musemanyana they journeyed to Moshaneng. At Konana they found an immense abundance of game: gnus, blessbocks, hartebeests, springbocks, and zebras grazed in herds. A very interesting account is given of Molema's town: the sale of brandy is prohibited; European cereals have been introduced; two missionaries were found here. Moshaneng is a Bechuana town, with a population of some 7000, many of whom have given up their heathen rites. Moloapolole was the next place visited. It was the residence of King Sechele, of whom we have lately heard a good deal. The number of his subjects was then estimated at about 35,000, while resident but non-tributary tribes amounted to from 18,000 to 20,000 more.

Dr. Holub describes the king, somewhat harshly we think, as looking every inch a hypocrite. The king's house, furnished in European fashion, had cost him some 3000*l*. He was the first of the six Bechuana kings to profess Christianity, but for all that he evidently is a believer in the doctrine that "the end justifies the means." Tea was served in cups; it was good, and the cakes unexceptionable; the sugar-basin, &c., were all of silver.

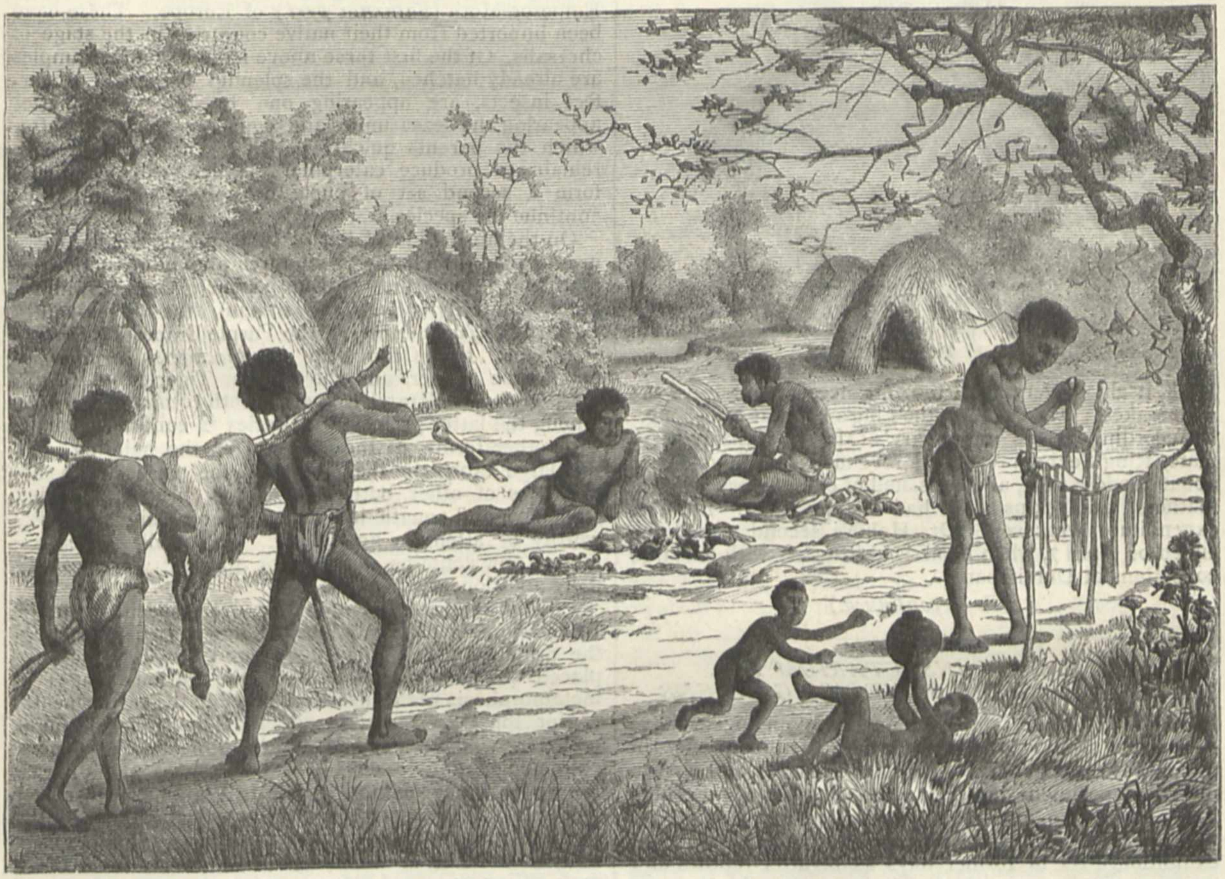

Fig. 2.

The king evidently enjoyed his tea, of which he swallowed nearly a quart. Addressing the king, Dr. Holub said: "When I was only thirteen years of age I read your name in Nyaka Livingstone's book. I little thought then that I should ever see you to speak to you; far more surprising is it to me to find myself drinking tea in your palace." The king, although still said to practise rain magic, replied sanctimoniously, "His ways are past finding out."

The Barwas and the Masarwas, although perhaps not really identical, are known by either name promiscuously amongst the Northern Bechuanas. They may be described as a cross between some branches of the Makalahari and the Bushmen. Their form, complexion, language, and customs afford various indications of their double origin. They are adepts at hunting, and are employed as hunters by their Bechuana masters. They use bows and arrows, and are very adroit in capturing animals by means of poisoned assegais. Their huts look something like large haycocks, consisting of a framework of stakes driven into the earth, fastened together firmly at the top, about five feet from the ground, and covered with a layer of twigs and dry grass. The Masarwas are of medium height, reddish-brown complexion, and a repulsive cast of countenance. They have a great aversion to agriculture and to cattle-breeding. They do not practise stone carving or use any stone utensils. They are very superstitious; treat their wives well, and show a great regard for their dogs. They pierce the nasal cartilage on reaching maturity; wear a body-cloth of hide. They suffer much from cold; but instead of lighting fires in their huts like the Korannas, regularly light these in the open air. The accompanying illustration shows these Masarwas at home.

From Molopole the route lay to Shoshong. This was the northern limit of this journey. It is the capital of the Eastern Bamangwatos, and the most important town in any of the independent native kingdoms in the interior of South Africa. It lies on the River Shoshon. The king's residence was built around the Kotla; the place has a circular space inclosed by a fence of strong stakes, the entrance being on the south side, opposite to which was an opening leading to another smaller inclosure, which was the king's cattle kraal, where his farm stock was kept at night, the horses being accommodated in the

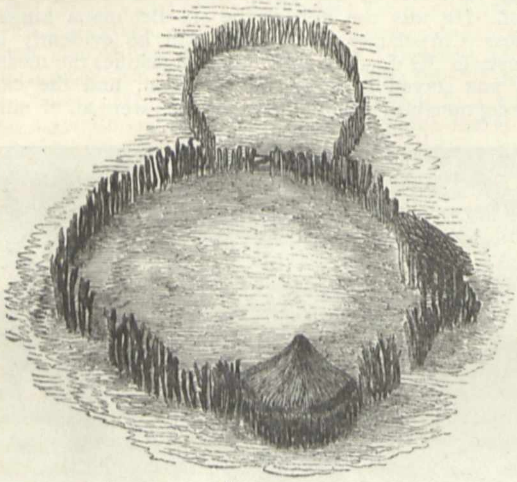

FIG. 3.

Kotla itself. Every night the entrances are made secure with stakes. Fig. 3 shows the king's kotla at Shoshong.

According to the missionary's (Mr. Mackenzie's) estimate, King Sekhomo's actual revenue was equivalent to about 3000*l*. a year, and consisted of cattle, ivory, ostrich-feathers, and skins; he had—happy man!—no state expenditure whatever. Dr. Holub's second expedition ended on April 7, when he arrived in safety with his large collections at Dutoitspan.

(*To be continued.*)

THE NEW INSECTARIUM IN THE ZOOLOGICAL SOCIETY'S GARDENS

ALTHOUGH of late years many entomologists have been in the habit of rearing insects in captivity for the purpose of watching their transformations and obtaining good specimens in each stage of existence, nothing like a systematic attempt, so far as we know, has been made to form a general collection of living insects for exhibition. As in former days as regards reptiles and the lower marine animals, so in the present instance as regards its insectarium, our Zoological Society seems to be first in the field; and so far as we can judge from the progress already made, to be likely, if not altogether successful, to attain many interesting and instructive results.

The building in the Regent's Park Gardens now used as an insectarium is constructed of iron and glass on three sides, with a brick back to it, and formerly formed part of the refreshment buildings. It was moved to its present site, on the north bank of the canal near the north entrance, last autumn, and has been used during the winter as a nursery for delicate monkeys and tropical birds. The cases containing the insects, to which it is now devoted, are arranged on stands all round the building, and also occupy two tables in the centre. The cases used for the principal specimens are formed of zinc plates. The upper part of them is glazed on all four sides, the top being formed of perforated zinc so as to admit the air. The food-plant or object required for the suspension of the chrysalises, when that stage of the insect is exhibited, is inserted into the case through a circular hole in the bottom, but the glass front also opens, so that ready access may be obtained to the interior. The larger cases in the front row measure about 24 inches in breadth by 18 in depth, and are 32 inches in height. The cases in the opposite row are of similar construction, but rather smaller in dimensions.

The cases on the south side (on each side of the entrance door) are mostly appropriated to the exhibition of the larger and finer species of silk-producing moths of the family Bombycidæ. Amongst them may be specially noticed Glover's Silk-moth (*Samia Gloveri*) and the Cercopian Silk-moth (*S. cecropia*) of North America, Perny's Silk-moth (*Attacus Pernyi*) of Northern China, the Tusseh Silk-moth (*A. mylitta*) of India, and the great Emperor Moth (*Saturnia pyri*) of Europe. These have been imported from their native countries in the stage of chrysalis. Of the first three above named, many examples are already hatched, and the splendid *imagines*, or perfect insects, are appearing one by one. Soon after appearing the sexes unite and eggs are produced, after which the parents quickly perish. The fertilised eggs remain to produce caterpillars, which will eventually form a second set of pupæ or chrysalises and thus continue the species.

On the north side of the Insectarium the smaller cases are devoted principally to the rarer and more noticeable moths and butterflies of Europe, such as the Swallow-tailed Butterfly (*Papilio machaon*), the Black-veined Butterfly (*Aporia cratægi*), the Purple Emperor (*Apatura iris*), and the Orange-tip (*Anthocharis cardamines*) among the former, and the Scarlet Tiger Moth (*Callimorpha dominula*) and Emperor Moth (*Saturnia carpini*) among the latter group. The series is continued, mixed with other forms, at the east end of the building. On the large tables in the middle of the Insectarium are examples of other butterflies, moths, beetles, mayflies, stoneflies, and aquatic insects of different kinds, all well worthy of attention and study. The whole series exhibited now contains examples of about fifty species, but daily additions are made to it.

Finally we should mention that every specimen in the Insectarium is distinctly labelled, and that over each of the principal cases is fixed a glazed box, in which are placed preserved specimens of the various stages of metamorphosis of the insect exhibited in the case beneath.

Nor must we forget to add that the Insectarium is under the sole charge of Mr. E. Watkins, an experienced entomologist and breeder of insects, whose name is well known to many naturalists. Mr. Watkins, whose services have been secured for the Zoological Society for the purpose of inaugurating this interesting exhibition, is in daily attendance at the Insectarium, and is most ready and willing to afford information and instruction to all who apply to him.

NOTES

THE numerous friends and still more numerous admirers of Prof. Gegenbaur will be glad to hear that he is now believed to be out of danger. It appears that the illness of the distinguished anatomist commenced with an attack of erysipelas, the origin of which is not known; it does not seem that the case was complicated by any blood poisoning, but there was an attack of peritonitis, which caused the very greatest anxiety for some days. Lately however his condition has considerably improved, but it will, of course, be a long time before he can be completely restored to health.

AT the *conversazione* given to Prof. Helmholtz at University College, Mr. Latimer Clark exhibited the accompanying interesting unpublished letter from Sir Isaac Newton to Dr. Law :—

"*London, Dec.* 15, 1716

"Dear Doctor : He that in ye mine of knowledge deepest diggeth, hath, like every other miner ye least breathing time, and must sometimes at least come to terr ; alt for air.

"In one of these respiratory intervals I now sit doune to write to you, my friend.

"You ask me how, with so much study, I manage to retene my health. Ah, my dear doctor, you have a better opinion of your lazy friend than he hath of himself. Morpheous is my best companion ; without 8 or 9 hours of him yr correspondent is not worth one scavenger's peruke. My practizes did at ye first hurt my stomach, but now I eat heartily enow as y' will see when I come down beside you.

"I have been much amused by ye singular φενομενα resulting from bringing of a needle into contact with a piece of amber or resin fricated on silke clothe. Ye flame putteth me in mind of sheet lightning on a small—how very small—scale. But I shall in my epistles abjure Philosophy whereof when I come down to Sakly I'll give you enow. I began to scrawl at 5 mins frm 9 of ye clk, and have in writing consmd 10 mins. My Ld. Somerset is announced.

"Farewell, Gd bless you and help yr sincere friend

"(Signed) ISAAC NEWTON

"To Dr. Law, Suffolk"

VERY great progress is being made in Paris to render the forthcoming Electric Exhibition a success. There are sixty-four English exhibitors. The Post Office is going to make a very good display, and as the old apparatus of Ampère and Œrsted will be shown, it is hoped that those of Faraday and Wheatstone will be added.

L'Électricien is the title of a new fortnightly journal published in Paris and devoted to the interests of the science of electricity. It might have been thought that with *L'Électricité*, edited by M. Wilfrid de Fonvielle, and *La Lumière Électrique*, edited by M. le Comte du Moncel, appearing every week, the field would have been fully occupied. The latter journal is however somewhat more special in its aims, and the former appears to be at present given over to discursive maunderings on natural photophony and to rabid attacks upon Clerk-Maxwell's theory of electricity. At any rate there appears to be scope for a journal of a somewhat different order ; and the pages of No. 1, now before us, contain valuable contributions from well-known pens. M. Mercadier contributes an article on the use of selenium in the photophone ; M. Niaudet-Breguet writes upon the different systems adopted for central stations in telephone exchanges ; Dr. de Cyon has an interesting article on electrobiology ; M. Gaston Tissandier discourses on one of the domestic applications of electricity ; while Prof. C. M. Gariel contributes a valuable discussion of the graphic method of representing Ohm's law and other laws of current electricity. The acting editor is M. E. Hospitalier, the well-known electrical engineer. The publication, which is illustrated, is got up in admirable style by the house of Gustave Masson. We wish all success to the undertaking so excellently begun.

THE Paris Municipal Laboratory for testing all matters having any bearing on health, and the organisation of which is now quite complete, was opened to the public on March 1. The establishment, which is situated at the Prefecture of Police, Quai du Marché Neuf, will be formally inaugurated to-morrow. The laboratory is already regarded as a success, the number of objects presented for analysis amounting in April to not less than 700, mostly wine purchased in shops, and suspected of being adulterated. The number of falsifications amounts to 80 out of 100. In every case where adulteration has been detected the results have been communicated to the competent authorities, who have prosecuted. Milk has been also sent in great quantity, and in many cases proved adulterated or mixed with water. The results of these inquiries have created such an agitation among Parisian milkmen that when they were surrounded at Batignoles Terminus and their boxes about to be opened for inspection, they resisted. A scuffle ensued between them and the police, and the result was that a number escaped. French chocolate has also been found very defective in quality, an immense number of substances having been added to it. The head of this new service is M. Ch. Gerard, a chemist of reputation. All the assistants are selected by competitive examination, and are only to remain in the service for a few years. They belong mostly to the School of Medicine and Pharmacy, so that the institution may be considered as a public school of practical chemistry. The general organisation is said to be modelled after the Chemical Laboratory at South Kensington. Notable features are the use of spectroscopic analysis combined with the electric spark, a workshop for photography, and the special service for trichinæ. The ordinary market-inspectors are trained to use special microscopes for that purpose. A special instrument has been constructed for boring in ham small holes which are not visible when cooked, and the particles of flesh so extirpated are analysed microscopically. A special apparatus has been designed and is in constant use for trying swine, and even the muscles of patients.

MR. MORRIS, the Director of Public Gardens and Plantationg in Jamaica, has recently issued a pamphlet entitled "Notes on Liberian Coffee, its History and Cultivation." In this pamphlet Mr. Morris has brought together a great deal of valuable matter connected with this remarkable species of *Coffea*, which will prove not only interesting to those who wish to see the resources of our Colonies developed, but particularly to those about to embark in the cultivation of coffee as an article of commerce. The pamphlet commences with some historical remarks on the species, and then touches on its introduction into Jamaica, followed by a consideration of the plant as found in Liberia, in the West and East Indies, of its propagation and the establishing of plantations with regard to climate, soil, and various other details ; some interesting notes follow on the yield of Liberian coffee trees, and of the commercial value of the coffee itself. In view of this pamphlet being of considerable use to persons abroad who may be about to embark in the cultivation of this particular species, we may say that it is issued from the Government Printing Establishment at Jamaica, and that its price is sixpence.

A NEW medicinal oil has just been introduced into this country by Messrs. Burgoyne and Burbidges, the well-known chemists of Coleman Street. It is known as Oolachan oil, and is said to be scarcely distinguishable from cod liver oil. It is obtained from a fish called by the North American Indians Oolachan, or candle fish, from the fact that when dried the fish itself can be used as a torch or candle on account of the large quantity of oleaginous matter it contains. The fish is met with on the coasts of Vancouver's Island and British Columbia, and in the bays between the Frazer and Skuna Rivers. Similar in its habits to the salmon, it ascends the rivers to spawn once a year, but remains only for a very short period, sometimes not more than a day, and as this is the only time they can be caught by the Indians, the manufacture of the oil is somewhat precarious. The fish itself, which is about the size of a herring, is much esteemed by the Indians on account of its delicacy of flavour and valuable medicinal properties. In America the oil has already a great reputation as a valuable and efficient substitute for cod liver oil, and there is every probability as it becomes known in this country of its taking a prominent place as an important medicine.

M. HERVÉ-MANGON, the director of the Conservatoire des Arts et Métiers, has established a manufacture of pottery in the large hall, in order to make the Parisian public acquainted with several of the manipulations used in the large manufactories. This demonstration, which will be continued during several

Sundays, bears principally on the use of the lathe for modelling. M. Hervé Mangon, having established a Siemens electro-magnetic machine for lighting purposes at the Conservatoire, sends by request supplies to the several laboratories of the establishment. Up to the present moment it has been used only by photographers.

AT the adjourned ordinary meeting of the Sanitary Institute, to be held at 9, Conduit Street, on Wednesday, May 18, at 8 p.m., the discussion will be continued upon the address delivered by Dr. Richardson, F.R.S., Chairman of Council—"Suggestions for the Management of Cases of Small Pox, and of other Infectious Diseases in the Metropolis and Large Towns."

AT the meeting of the Iron and Steel Institute last week the papers were almost entirely of a purely technical or commercial character.

MR. CHARLES E. TURNER, Lector at the University of St. Petersburg, will begin a course of five lectures at the Royal Institution, on the Great Modern Writers of Russia—Pouschkin, Lermontoff, Gogol, Tourgenieff and Nekrasoff—on Saturday, the 21st.

AN International Medical Congress meets at Madrid on the 20th inst.

THE extinction of the Brush electric light in the City last week is stated to have been caused by the defective insulation of the wires.

ALL the large railway companies in the country have intimated their intention of sending engines to the typical engine exhibition to be held at Newcastle on the occasion of the Stephenson centenary.

THE annual meeting of the U.S. Society for the Promotion of Agricultural Science will be held at Cincinnati on Tuesday, August 16, the day preceding the session of the American Association for the Advancement of Science.

THE fifth and concluding course of Cantor Lectures for the present session at the Society of Arts will be by Mr. R. Brudenell Carter, on the subject of "Colour Blindness, and its Influence on Various Industries." The course consists of three lectures, the first of which will be delivered upon Monday next, the 16th inst. This lecture will deal generally with the subject. The second lecture will treat of methods of testing for colour blindness, the prevalence of the affection, mistakes of the colour blind, and methods of endeavouring to counteract the defect. The subject of the third lecture is specially the industries chiefly affected by colour blindness. In it an account will be given of recent legislation on the subject in America, and the necessity for it in this country.

MASSON of Paris has issued a third series of Prof. Paul Bert's "Revues scientifiques," published in the *République Française*.

THE Annual Report of the Belfast Naturalists' Field Club for 1879-80 tells of its continued prosperity, and contains an account of the various excursions made during last summer. Appended are "A List of the Post-Tertiary Foraminifera of the North-East of Ireland," by Joseph Wright, F.G.S., and "A List of the Mollusca of the Boulder Clay of the North-East of Ireland," by S. A. Stewart.

THE Birmingham Natural History Society has issued a *Report and Transactions* for 1880, which in quantity and quality does its members great credit. There is an interesting address by the president, Mr. W. Southall, and a number of natural history papers, some by outsiders, and one or two on subjects connected with local natural history. The Society is now housed in the Mason College.

IN compliance with the provisions of a recent decree, the system of Algerian telegraphy has been *rattaché* to the French administration, and is governed from Paris. The head of the Algerian service has been appointed director at Lyons.

THE annual *conversazione* given by the President and Council of the Royal Society was held on Wednesday last week. It was well attended, and there were numerous scientific and artistic novelties on view.

MR. E. IM THURM is writing on Aspects of Plant Life in British Guiana, in the *Gardeners' Chronicle*.

THE additions to the Zoological Society's Gardens during the past week include a Black-faced Spider Monkey (*Ateles ater*) from Eastern Peru, a Collared Peccary (*Dicotyles tajaçu*) from South America, presented by Mr. E. H. Dance; a Roseate Cockatoo (*Cacatua roseicapilla*) from Australia, presented by Sir Charles C. Smith, Bart.; a Swift (*Cypselus apus*), European, presented by Mr. H. H. Johnston; a Common Viper (*Vipera berus*), British, presented by Mr. John Poyer Poyer.

OUR ASTRONOMICAL COLUMN

THE COMET OF 1812.—Under certain suppositions as regards the epoch of perihelion passage of this comet, the return of which may now be expected, it will be necessary to search for it on a particular date, upon the assumption that it has yet a considerable orbital angle to describe before arriving in perihelion, because the geocentric position corresponding to a small orbital angle will place the comet too near to the sun's position to allow of observations. If we employ the elliptical elements deduced by Mr. W. E. Plummer from a new reduction and discussion of several of the most reliable series of observations in 1812, we find the following values of the comet's heliocentric equatorial co-ordinates and of the radius vector for intervals of 100 days to 60 days before perihelion passage; the co-ordinates are referred to the equinox of 1881·0.

Time from perihelion.	*x*.	*y*.	*z*.	Log. radius-vector.
– 100 days	+0·5619	–0·5939	+1·6649	0·2683
– 90 ,,	+0·5478	–0·4432	+1·5725	0·2363
– 80 ,,	+0·5305	–0·2904	+1·4712	0·2016
– 70 ,,	+0·5093	–0·1357	+1·3592	0·1637
– 60 ,,	+0·4832	+0·0209	+1·2337	0·1222

Combining these co-ordinates with the X, Y, Z of the *Nautical Almanac* for May 27·5 and June 26·5, days of new moon in the present year, we get the following results:—

For May 27·5

t.	R.A. °	Decl. °	Distance from earth.	Intensity of light.
– 100 days	15·2	+63·9	2·267	0·057
– 90 ,,	23·5	62·0	2·201	0·070
– 80 ,,	31·2	59·4	2·140	0·086
– 70 ,,	38·3	56·2	2·083	0·108
– 60 ,,	44·8	+52·2	2·030	0·139

For June 26·5

t.	R.A. °	Decl. °	Distance from earth.	Intensity of light.
– 100 days	35·7	+74·5	2·146	0·063
– 90 ,,	47·1	71·4	2·084	0·078
– 80 ,,	55·8	67·6	2·027	0·096
– 70 ,,	62·5	63·1	1·976	0·120
– 60 ,,	67·8	+57·9	1·931	0·153

These places will define the region of the sky where the comet should be sought, and telescopes of good optical capacity will be needed. When Pons discovered the comet on July 20, 1812, the theoretical intensity of light was 0·18.

The mean motion in 1812 not being ascertainable within very narrow limits, no attempt, so far as we know, has been made to determine the effect of perturbation in the present revolution, and we have therefore to be content with the method of careful sweeping over the region of the sky, on which the orbit may be projected at any time. Sir George Airy's orbit-sweeper, it is true, would limit the extent of sky-ground to be examined, but we suspect the only instrument of sufficient power yet mounted upon his principle is that at the Imperial Observatory at Strassburg, where it is not to be doubted that it will be put in active operation by Prof. Winnecke. We may remind the reader that sweeping ephemerides for the whole year were published from Strassburg some time since, and will be found in the *Viertel-jahrsschrift der Astronomischen Gesellschaft*, Jahrgang 12. Those given above apply to greater distance from perihelion.

THE TRANSIT OF VENUS, 1882.—At the sitting of the Paris Academy of Sciences, on the 2nd inst., the Minister of Foreign Affairs transmitted a letter from the British Ambassador, on the part of his Government, desiring to be informed with which French authorities the Royal Society of London should communicate, with the view to an interchange of opinions relative to the observation of the approaching transit of Venus. The letter was referred to a commission already nominated.

COMET 1880, V. (PECHÜLE, DECEMBER 16).—This comet was followed by M. Bigourdan until March 31, efforts having been made at the Observatory of Paris to observe it as long as possible on account of the resemblance of the orbit to that of the great comet of 1807. M. Bigourdan's last elements gave the place with errors of only 2s.·0 in right ascension, and 20″ in declination: they will be found in *Comptes rendus*, vol. xcii. p. 172.

COMET 1881, *a* (SWIFT, MAY 1).—We have received from the Imperial Observatory of Strassburg the following observation of the new comet, made by Dr. Hartwig with the "orbit-sweeper":—

May 5, at 14h. 56m. 9s.·8 mean time at Strassburg.
Right Ascension 0h. 19m. 17s.·76; Declination $+32° 19' 32''·3$.

CHEMICAL NOTES

IN the *American Chemical Journal* Prof. Mallet describes a simple form of calorimeter whereby the specific heats of moderately small quantities of solids or liquids may be measured with a fair degree of accuracy. Mercury is employed, instead of water, as the material whose temperature is raised, and comparison is made, not of the total amounts of heat given out by different bodies on cooling, but of fractions of this heat rendered as nearly as possible equal.

IN *Compt. rend.* Berthelot gives several thermal measurements showing that in the substitution of halogens for hydrogen in hydrocarbons, the quantity of heat evolved varies according to the series and chemical function of the hydrocarbons employed, and is generally smaller the greater the number of halogen atoms substituted. The heat of formation of chloral alcoholate in various physical states is also considered by Berthelot: among other results it is shown that chloral hydrate is decomposed by an excess of absolute alcohol, but that the alcoholate is decomposed by much water; in the former of these actions there is exhibited the decomposition of a more volatile compound—chloral hydrate—and formation of a less volatile—chloral alcoholate; and at the same time the expulsion of a less volatile substance—water—by a more volatile—alcohol.

THE proto-salts of chromium (or chromous salts) are unstable and but little known: in *Compt. rend.* M. Moissau describes two salts belonging to this series, viz., chromous chloride, $CrCl_2$, and chromous sulphate, $CrSO_4 7H_2O$.

IN the *Berichte* of the German Chemical Society Herr C. Zimmermann states that potassium permanganate may be used for determining iron in presence of considerable quantities of hydrochloric acid, if a solution of manganous chloride, or preferably manganous sulphate, be added previous to titration.

ACCORDING to the hypothesis of Vant' Hoff, propyl glycol ought to be an optically active liquid, inasmuch as the molecule of this compound contains one *asymmetric* carbon atom, *i.e.* an atom directly united with four different radicles;—propyl glycol being formulated as

$$\begin{array}{c} CH_3\text{—}C\text{—}CH_2OH \\ \diagup\ \diagdown \\ H \quad OH \end{array}$$

. Le Bel has recently shown (*Compt. rend.*) that if ordinary propyl glycol—from glyceric acid—be subjected to partial fermentation, the unfermented residue exhibits slight dextrorotatory powers. Le Bel thinks that ordinary propyl glycol contains both an optically active and an optically inactive modification, and that the latter being decomposed by the ferment, the presence of the former is rendered evident. From optically active propyl glycol Le Bel has prepared an active propylene oxide boiling at 35°, which he states is the most volatile optically active compound at present known.

A SERIES of optically active amylamines is described in *Compt. rend.* by M. Plimpton. These compounds are obtained from amyl bromide—from active amylic alcohol—by the action of alcoholic ammonia.

IN *Chem. Centralblatt* E. Ludwig describes experiments on the localisation of arsenic, absorbed as arsenious oxide, in the animal organism: contrary to the results of many former experimenters, Ludwig asserts that an accumulation of arsenic occurs in the liver: neither the bones nor the brain retain arsenic for any length of time. Arsenic was detected in the liver of a dog forty days after the last dose had been administered, but no trace could be found in the brain, bones, or muscles. Ludwig's results are generally confirmed by Johnson and Chittenden (*Amer. Chem. Journ.*).

MM. DES CLOIZEAUX AND DAMOUR describe (*Compt. rend.*) a new selenite of copper, to which they give the name *Chalcomenite*. The mineral occurs in the Argentine Republic, in small green clinorhombic crystals, associated with selenite of lead, and selenite of lead and copper.

M. SULLIOT proposes (*Compt. rend.*) to employ "chamber crystals" as a disinfectant. He places a solution of these crystals in sulphuric acid in the room or other place to be disinfected; the atmospheric moisture slowly decomposes the liquid with liberation of oxides of nitrogen, which destroy noxious organic matter present in the air.

MR. M. W. WILLIAMS describes, in *Chem. Soc. Journal*, a method for freeing water, to be analysed by the process of Frankland and Armstrong, from nitrates and ammonia. He digests the water with carefully-prepared "copper-zinc couple," whereby all nitrates are reduced to ammonia; he then distils off ammonia, evaporates to dryness, and proceeds in the usual manner. The use of sulphurous acid, which has always been much objected to, is thus obviated.

IN the same journal there is a suggestive paper by Prof. Hartley on the "Relation between the molecular structure of carbon compounds and their absorption-spectra." Evidence is accumulated in favour of the view that the selective absorption exhibited by "aromatic" compounds depends on the vibrations of the carbon atoms within the molecule, but that these atomic vibrations are dependent upon the nature of the molecular vibrations themselves, and are probably to be regarded as harmonics of these fundamental vibrations.

THE second and third parts of the *Gazetta Chimica Italiana* for the present year exhibit very unmistakably the activity of Italian chemists, chiefly in the domain of organic chemistry. Schiff continues his researches on Glucosides; the derivatives of thymol are studied by Paternò and Canzoneri; Macagno describes experiments on the spectroscopic detection of artificial colouring matters in wines. Koenig, Schiaparelli, Barbaglia, and other known chemists contribute papers.

GEOGRAPHICAL NOTES

MR. EDWARD WHYMPER on Monday last addressed a large meeting of the Geographical Society on some features in his recent journey among the Great Andes of the Equator. His paper was not, however, of so popular a nature as those which he read before the Alpine Club and the Society of Arts. The chief facts left on the minds of his very attentive audience may be briefly stated Mr. Whymper found by careful experiments that aneroid barometers are not to be depended upon for the determination of heights, and that there is a remarkable difference in altitudes as fixed by the boiling point of water and the mercurial barometer. He asserted, as the result of his observations, that it is a mistake to suppose that there are two parallel chains in the Ecuadorian Andes, as usually shown on our maps. This is a point, however, on which more light is evidently required. Mr. Whymper's account of his ascent of the hitherto unknown peak called Sara-Urcu, was very interesting, and this achievement alone would stamp him a mountaineer of the highest skill and courage.

THE following award has just been made of the medals given annually by the Council of the Geographical Society for competition among a limited number of public schools:—Physical Geography (Mr. H. N. Moseley, F.R.S., examiner): Gold medal, E. G. Reid, Dulwich College; silver medal, Sydney Edkins, City of London School; Political Geography (Right Rev. Bishop Abraham, examiner): Gold medal, Theodore

Brooks, London International College; silver medal, Chas. Th. Knaus, Dulwich College.

THE *Willem Barents*, the little Polar ship which has already made three voyages to the Northern Polar Sea, has left Amsterdam for the fourth time. The crew consists of a lieutenant of the Royal Navy, H. van Broekhuyzen, as captain, two other officers, a physician, a zoologist, a photographer (the Englishman, Mr. Grant), and six sailors.

DOCTORS ARTHUR AND AUREL KRAUSE have left Bremen to spend some time in the neighbourhood of Behring Straits for the purpose of exploring and collecting, at the expense of the Bremen Geographical Society. They will visit the Chukchi peninsula, Behring Islands, and Alaska, where they will make zoological collections and carry on various scientific observations.

MR. HENRY SOLTAU and Mr. J. W. Stevenson, of the China Inland Mission, have successfully made the journey from Bhamo into China, reaching I-chan-fu, on the Yang-tsze-kiang, on March 14. This is the first time that it has been accomplished by Europeans, and the time occupied was about four months.

THE first paper in the May number of *Petermann's Mittheilungen* is a study of the Padolian Dniester region by Ritter v. Habdank Dumkowski. This is followed by the continuation of Dr. Radde's account of his journey to Talysh, Aderbeijan and the Sawalan; M. Charnay's expedition to Central America from the *North American Review*; M. Potanin's researches in Western Mongolia in 1876-77, with a map; Recent Surveys in the Western United States, with a map; and the usual Monthly Notes. Among the latter is a long account of Dr. Lenz's journey to Timbuctoo, with a sketch-map.

WE have received Nos. 1 and 3 of the *Bulletin* of the American Geographical Society, the two most important papers in which are on the recent investigations of the Gulf Stream, by the U.S. Coast Survey steamer *Blake*, by Commander J. R. Bartlett, and Changes in the Physical Geography of the Ancient Home of Man in Central and Western Asia, by the Rev. Owen Street.

DR. MOFFAT, the venerable missionary and pioneer explorer in Africa, was entertained at a banquet in the Mansion House on Saturday.

THE *Bulletin* of the Society of Commercial Geography of Bordeaux contains a brief statement of M. Paul Soleillet's views on the African question. After addressing the Society M. Soleillet proceeded to Paris, but he entertains hopes of being able to return to West Africa in November.

THE PRODUCTION OF SOUND BY RADIANT ENERGY [1]

IN my Boston paper on the photophone (NATURE, vol. xxii. p. 500) the discovery was announced that thin disks of very many different substances *emitted sounds* when exposed to the action of a rapidly-interrupted beam of sunlight. The great variety of material used in these experiments led me to believe that sonorousness under such circumstances would be found to be a general property of all matter.

At that time we had failed to obtain audible effects from masses of the various substances which became sonorous in the condition of thin diaphragms, but this failure was explained upon the supposition that the molecular disturbance produced by the light was chiefly a surface action, and that under the circumstances of the experiments the vibration had to be transmitted through the mass of the substance in order to affect the ear. It was therefore supposed that if we could lead to the ear air that was directly in contact with the illuminated surface, louder sounds might be obtained, and solid masses be found to be as sonorous as thin diaphragms. The first experiments made to verify this hypothesis pointed towards success. A beam of sunlight was focussed into one end of an open tube, the ear being placed at the other end. Upon interrupting the beam, a clear musical tone was heard, the pitch of which depended upon the frequency of the interruption of the light and the loudness upon the material composing the tube.

While in Paris a new form of the experiment occurred to my mind, which would not only enable us to investigate the sounds produced by masses, but would also permit us to test the more general proposition that sonorousness, under the influence of intermittent light, is a property common to all matter. The substance to be tested was to be placed in the interior of a transparent vessel made of some material which (like glass) is transparent to light but practically opaque to sound.

Under such circumstances the light could get in, but the sound produced by the vibration of the substance could not get out. The audible effects could be studied by placing the ear in communication with the interior of the vessel by means of a hearing tube.

Some preliminary experiments were made in Paris to test this idea, and the results were so promising that they were communicated to the French Academy on October 11, 1880, in a note read for me by Mr. Antoine Breguet.

I wrote to Mr. Tainter suggesting certain experiments, and upon my return to Washington in the early part of January, Mr. Tainter communicated to me the results of the experiments he had made in my laboratory during my absence in Europe. He had commenced by examining the sonorous properties of a vast number of substances inclosed in test-tubes in a simple empirical search for loud effects. He was thus led gradually to the discovery that cotton-wool, worsted, silk, and fibrous materials generally, produced much louder sounds than hard rigid bodies like crystals, or diaphragms such as we had hitherto used.

In order to study the effects under better circumstances he inclosed his materials in a conical cavity in a piece of brass closed by a flat plate of glass. A brass tube leading into the cavity served for connection with the hearing-tube. When this conical cavity was stuffed with worsted or other fibrous materials the sounds produced were much louder than when a test-tube was employed. Mr. Tainter next collected silks and worsteds of different colours, and speedily found that the darkest shades produced the best effects. Black worsted especially gave an extremely loud sound.

About a teaspoonful of lamp-black was placed in a test-tube and exposed to an intermittent beam of sun-light. The sound produced was much louder than any heard before. Upon smoking a piece of plate-glass, and holding it in the intermittent beam with the lamp-black surface towards the sun, the sound produced was loud enough to be heard, with attention, in any part of the room. With the lamp-black surface turned from the sun the sound was much feebler.

Upon smoking the interior of the conical cavity and then exposing it to the intermittent beam with the glass lid in position as shown, the effect was perfectly startling. The sound was so loud as to be actually painful to an ear placed closely against the end of the hearing-tube. The sounds, however, were sensibly louder when we placed some smoked wire gauze in the receiver.

When the beam was thrown into a resonator, the interior of which had been smoked over a lamp, most curious alternations of sound and silence were observed. The interrupting disk was set rotating at a high rate of speed, and was then allowed to come gradually to rest. An extremely feeble musical tone was at first heard, which gradually fell in pitch as the rate of interruption grew less. The loudness of the sound produced varied in the most interesting manner. Minor reinforcements were constantly occurring, which became more and more marked as the true pitch of the resonator was neared. When at last the frequency of interruption corresponded to the frequency of the fundamental of the resonator, the sound produced was so loud that it might have been heard by an audience of hundreds of people.

The extremely loud sounds produced from lamp-black have enabled us to demonstrate the feasibility of using this substance in an articulating photophone in place of the electrical receiver formerly employed. Words and sentences spoken into the transmitter in a low tone of voice were audibly reproduced by the lamp-black receiver at forty metres distance.

In regard to the sensitive materials that can be employed, our experiments indicate that in the case of solids the physical condition and the colour are two conditions that markedly influence the intensity of the sonorous effects. The loudest sounds are produced from substances in a loose, porous, spongy condition, and from those that have the darkest or most absorbent colours. The materials from which the best effects have been produced are cotton-wool, worsted, fibrous materials generally, cork, sponge, platinum and other metals in a spongy condition, and lamp-black.

The loud sounds produced from such substances may perhaps be explained in the following manner: Let us consider, for

[1] Abstract of a paper by Prof. Alexander Graham Bell, read before the National Academy of Arts and Sciences, April 21, 1881.

example, the case of lamp-black—a substance which becomes heated by exposure to rays of all refrangibility. I look upon a mass of this substance as a sort of sponge, with its pores filled with air instead of water. When a beam of sunlight falls upon this mass the particles of lamp-black are heated, and consequently expand, causing a contraction of the air-spaces or pores among them. Under these circumstances a pulse of air should be expelled, just as we would squeeze out water from a sponge. The force with which the air is expelled must be greatly increased by the expansion of the air itself, due to contact with the heated particles of lamp-black. When the light is cut off the converse process takes place. The lamp-black particles cool and contract, thus enlarging the air-spaces among them, and the inclosed air also becomes cool. Under these circumstances a partial vacuum should be formed among the particles, and the outside air would then be absorbed as water is by a sponge when the pressure of the hand is removed.

I imagine that in some such manner as this a wave of condensation is started in the atmosphere each time a beam of sunlight falls upon lamp-black, and a wave of rarefaction is originated when the light is cut off. We can thus understand how it is that a substance like lamp-black produces intense sonorous vibrations in the surrounding air, while at the same time it communicates a very feeble vibration to the diaphragm or solid bed upon which it rests.

In his paper read before the Royal Society on March 10 Mr. Preece describes experiments from which he claims to have proved that the effects are wholly due to the vibrations of the confined air, and that the disks do not vibrate at all.

But for reasons stated Mr. Bell concludes that in the case of thin disks a real vibration of the diaphragm is caused by the action of the intermittent beam, independently of any expansion and contraction of the air confined in the cavity behind the diaphragm. Lord Rayleigh has shown mathematically that a to-and-fro vibration, of sufficient amplitude to produce an audible sound, would result from a periodical communication and abstraction of heat, and he says: "We may conclude, I think, that there is at present no reason for discarding the obvious explanation that the sounds in question are due to the bending of the plates under unequal heating" (NATURE, vol. xxiii. p. 274).

[Mr. Bell then describes experiments (devised by Mr. Tainter) which have given results decidedly more favourable, in his opinion, to the theory of Lord Rayleigh than to that of Mr. Preece.]

The list of solid substances that have been submitted to experiment in my laboratory is too long to be quoted here, and I shall merely say that we have not yet found one solid body that has failed to become sonorous under proper conditions of experiment.[1]

The sounds produced by liquids are much more difficult to observe than those produced by solids. The high absorptive power possessed by most liquids would lead one to expect intense vibrations from the action of intermittent light, but the number of sonorous liquids that have so far been found is extremely limited, and the sounds produced are so feeble as to be heard only by the greatest attention and under the best circumstances of experiment. In the experiments made in my laboratory a very long test-tube was filled with the liquid under examination, and a flexible rubber-tube was slipped over the mouth far enough down to prevent the possibility of any light reaching the vapour above the surface. Precautions were also taken to prevent reflection from the bottom of the test-tube. An intermittent beam of sunlight was then focussed upon the liquid in the middle portion of the test-tube by means of a lens of large diameter.

Results

Clear water	No sound audible.
Water discoloured by ink	Feeble sound.
Mercury	No sound heard.
Sulphuric ether *	Feeble, but distinct sound.
Ammonia	,, ,,
Ammonio-sulphate of copper	,, ,,
Writing ink	,, ,,
Indigo in sulphuric acid	,, ,,
Chloride of copper *	,, ,,

The liquids distinguished by an asterisk gave the best sounds.

[1] Carbon and thin microscope glass are mentioned in my Boston paper as non-responsive, and powdered chlorate of potash in the communication to the French Academy (*Comptes rendus*, vol. xci., p. 595). All these substances have since yielded sounds under more careful conditions of experiment.

Acoustic vibrations are always much enfeebled in passing from liquids to gases, and it is probable that a form of experiment may be devised which will yield better results by communicating the vibrations of the liquid to the air through the medium of a solid rod.

The vapours of the following substances were found to be highly sonorous in the intermittent beam:—Water vapour, coal gas, sulphuric ether, alcohol, ammonia, amylene, ethyl bromide, diethylamene, mercury, iodine, and peroxide of nitrogen. The loudest sounds were obtained from iodine and peroxide of nitrogen. I have now shown that sounds are produced by the direct action of intermittent sunlight from substances in every physical condition (solid, liquid, and gaseous), and the probability is therefore very greatly increased that sonorousness under such circumstances will be found to be a universal property of matter.

At the time of my communication to the American Association the loudest effects obtained were produced by the use of selenium, arranged in a cell of suitable construction and placed in a galvanic circuit with a telephone. But the selenium was very inconstant in its action, and from experiments by Dr. Chichester Bell of University College of London, it was found that all the selenium used was tainted with impurities.

Prof. W. G. Adams (*Proceedings* Royal Society, vol. xxiv. p. 163) has shown that tellurium, like selenium, has its electrical resistance affected by light, and we have found that when this tellurium spiral is connected in circuit with a galvanic battery and telephone and exposed to the action of an intermittent beam of sunlight, a distinct musical tone is produced by the telephone.

It occurred to Mr. Tainter before my return to Washington last January that the very great molecular disturbance produced in lamp-black by the action of intermittent sunlight should produce a corresponding disturbance in an electric current passed through it, in which case lamp-black could be employed in place of selenium in an electrical receiver. This has turned out to be the case, and the importance of the discovery is very great, especially when we consider the expense of such rare substances as selenium and tellurium.

We have observed that different substances produce sounds of very different intensities under similar circumstances of experiment, and it has appeared to us that very valuable information might be obtained if we could measure the audible effects produced. For this purpose we have constructed several different forms of apparatus for studying the effects, but our researches are not yet complete. When a beam of light is brought to a focus by means of a lens the beam diverging from the focal point becomes weaker as the distance increases in a calculable degree. Hence if we can determine the distances from the focal point at which two different substances emit sounds of equal intensity we can calculate their relative sonorous powers. Preliminary experiments were made by Mr. Tainter during my absence in Europe to ascertain the distance from the focal point of a lens at which the sound produced by a substance became inaudible. A few of the results obtained will show the enormous differences existing between different substances in this respect.

Distance from Focal Point of Lens at which Sounds become Inaudible with Different Substances

		m.
Zinc diaphragm (polished)		1·51
Hard rubber diaphragm		1·90
Tin foil	,,	2·00
Telephone	,, (japanned iron)	2·15
Zinc	,, (unpolished)	2·15
White silk	(in receiver)	3·10
White worsted	,,	4·01
Yellow worsted	,,	4·06
Yellow silk	,,	4·13
White cotton-wool	,,	4·38
Green silk	,,	4·52
Blue worsted	,,	4·69
Purple silk	,,	4·82
Brown silk	,,	5·02
Black silk	,,	5·21
Red silk	,,	5·24
Black worsted	,,	6·50
Lamp-black. In receiver the limit of audibility could not be determined on account of want of space. Sound perfectly audible at a distance of		10·00

Mr. Tainter was convinced from these experiments that this field of research promised valuable results, and he at once devised an apparatus for studying the effects, which he described to me upon my return from Europe. [The apparatus has since been constructed, and Mr. Bell gave a detailed description of it.]

The meaning we have uniformly attached to the words "photophone" and "light" will be obvious from the following passage quoted from my Boston paper :—

"Although effects are produced as above shown by forms of radiant energy, which are invisible, we have named the apparatus for the production and reproduction of sound in this way the 'photophone,' because an ordinary beam of light contains the rays which are operative."

To avoid in future any misunderstandings upon this point we have decided to adopt the term "*radiophone*" proposed by M. Mercadier as a general term signifying an apparatus for the production of sound by any form of radiant energy, limiting the words *thermophone*, *photophone*, and *actinophone* to apparatus for the production of sound by thermal, luminous, or actinic rays respectively. M. Mercadier, in the course of his researches in radiophony, passed an intermittent beam from an electric lamp through a prism, and then examined the audible effects produced in different parts of the spectrum (*Comptes rendus*, December 6, 1880). We have repeated this experiment, using the sun as our source of radiation, and have obtained results somewhat different from those noted by M. Mercadier. A beam of sunlight was reflected from a heliostat through an achromatic lens, so as to form an image of the sun upon the slit. The beam then passed through another achromatic lens and through a bisulphide of carbon prism, forming a spectrum of great intensity, which, when focussed upon a screen, was found to be sufficiently pure to show the principal absorption lines of the solar spectrum. The disk-interrupter was then turned with sufficient rapidity to produce from five to six hundred interruptions of the light per second, and the spectrum was explored with the receiver, which was so arranged that the lamp-black surface exposed was limited by a slit, as shown.

Under these circumstances sounds were obtained in every part of the visible spectrum, excepting the extreme half of the violet, as well as in the ultra-red. A continuous increase in the loudness of the sound was observed upon moving the receiver gradually from the violet into the ultra-red. The point of maximum sound lay very far out in the ultra-red. Beyond this point the sound began to decrease, and then stopped so suddenly that a very slight motion of the receiver made all the difference between almost maximum sound and complete silence.

2. The lamp-blacked wire gauze was then removed and the interior of the receiver was filled with red worsted. Upon exploring the spectrum as before, entirely different results were obtained. The maximum effect was produced in the green at that part where the red worsted appeared to be black. On either side of this point the sound gradually died away, becoming inaudible on the one side in the middle of the indigo, and on the other at a short distance outside the edge of the red.

3. Upon substituting green silk for red worsted the limits of audition appeared to be the middle of the blue and a point a short distance out in the ultra-red. Maximum in the red.

4. Some hard-rubber shavings were now placed in the receiver. The limits of audibility appeared to be on the one hand the junction of the green and blue, and on the other the outside edge of the red. Maximum in the yellow. Mr. Tainter thought he could hear a little way into the ultra-red, and to his ear the maximum was about the junction of the red and orange.

5. A test-tube containing the vapour of sulphuric ether was then substituted for the receiver. Commencing at the violet end, the test-tube was gradually moved down the spectrum and out into the ultra-red without audible effect, but when a certain point far out in the ultra-red was reached a distinct musical tone suddenly made its appearance, which disappeared as suddenly on moving the test-tube a very little further on.

6. Upon exploring the spectrum with a test-tube containing the vapour of iodine the limits of audibility appeared to be the middle of the red and the junction of the blue and indigo. Maximum in the green.

7. A test-tube containing peroxide of nitrogen was substituted for that containing iodine. Distinct sounds were obtained in all parts of the visible spectrum, but no sounds were observed in the ultra-red.

The maximum effect seemed to me to be in the blue. The sounds were well-marked in all parts of the violet, and I even fancied that the audible effect extended a little way into the ultra-violet, but of this I cannot be certain. Upon examining the absorption-spectrum of peroxide of nitrogen it was at once observed that the maximum sound was produced in that part of the spectrum where the greatest number of absorption lines made their appearance.

8. The spectrum was now explored by a selenium cell, and the audible effects were observed by means of a telephone in the same galvanic circuit with the cell. The maximum effect was produced in the red. The audible effect extended a little way into the ultra-red on the one hand and up as high as the middle of the violet on the other.

Although the experiments so far made can only be considered as preliminary to others of a more refined nature, I think we are warranted in concluding that the nature of the rays that produce sonorous effects in different substances depends upon the nature of the substances that are exposed to the beam, and that the sounds are in every case due to those rays of the spectrum that are absorbed by the body.

Our experiments upon the range of audibility of different substances in the spectrum have led us to the construction of a new instrument for use in spectrum analysis. The eye-piece of a spectroscope is removed, and sensitive substances are placed in the focal point of the instrument behind an opaque diaphragm containing a slit. These substances are put in communication with the ear by means of a hearing-tube, and thus the instrument is converted into a veritable "spectrophone."

Suppose we smoke the interior of our spectrophonic receiver, and fill the cavity with peroxide of nitrogen gas. We have then a combination that gives us good sounds in all parts of the spectrum (visible and invisible) except the ultra violet. Now pass a rapidly-interrupted beam of light through some substance whose absorption spectrum is to be investigated, and bands of sound and silence are observed upon exploring the spectrum, the silent positions corresponding to the absorption bands. Of course the ear cannot for one moment compete with the eye in the examination of the visible part of the spectrum; but in the invisible part beyond the red, where the eye is useless, the ear is invaluable. In working in this region of the spectrum lamp-black alone may be used in the spectrophonic receiver. Indeed the sounds produced by this substance in the ultra-red are so well marked as to constitute our instrument a most reliable and convenient substitute for the thermo-pile. A few experiments that have been made may be interesting.

1. The interrupted beam was filtered through a saturated solution of alum.

Result: The range of audibility in the ultra-red was slightly reduced by the absorption of a narrow band of the rays of lowest refrangibility. The sounds in the visible part of the spectrum seemed to be unaffected.

2. A thin sheet of hard rubber was interposed in the path of the beam.

Result: Well-marked sounds in every part of the ultra-red. No sounds in the visible part of the spectrum, excepting the extreme half of the red.

These experiments reveal the cause of the curious fact alluded to in my paper read before the American Association last August—that sounds were heard from selenium when the beam was filtered through both hard rubber and alum at the same time.

3. A solution of ammonia-sulphate of copper was tried.

Result: When placed in the path of the beam the spectrum disappeared, with the exception of the blue and violet end. To the eye the spectrum was thus reduced to a single broad band of blue-violet light. To the ear however the spectrum revealed itself as two bands of sound with a broad space of silence between. The invisible rays transmitted constituted a narrow band just outside the red.

I think I have said enough to convince you of the value of this new method of examination, but I do not wish you to understand that we look upon our results as by any means complete. It is often more interesting to observe the first totterings of a child than to watch the firm tread of a full-grown man, and I feel that our first footsteps in this new field of science may have more of interest to you than the fuller results of mature research. This must be my excuse for having dwelt so long upon the details of incomplete experiments.

I recognise the fact that the spectrophone must ever remain a mere adjunct to the spectroscope, but I anticipate that it has a wide and independent field of usefulness in the investigation of absorption spectra in the ultra-red.

ON AN ACOUSTIC PHENOMENON NOTICED IN A CROOKES TUBE[1]

A SHORT time since, while experimenting with a Crookes tube, I noticed a phenomenon which was quite striking, and so evident that it hardly seems possible that it has not frequently been observed before; but as no allusion to the effect in question has come to my notice, I venture to call attention to it.

In working with the tube in which a piece of sheet platinum is rendered incandescent by the concentration upon it of electrified particles, repelled from a concave mirror, I noticed that when the mirror was made the negative electrode, so that this concentration took place, a clear and quite musical note issued from the tube. I thought at first that the pitch of the note would coincide with that produced by the circuit-breaker used with the coil (which made about 100 breaks per second), but this did not prove to be the case. In fact very great changes in the rate of the circuit-breaker did not affect the note given by the tube. The effect seemed to be produced by the vibration of the sheet-platinum in its own period, under the influence of the molecular impact, which vibration was communicated to the glass walls of the tube by the enamel rod to which the platinum was attached, giving rise to a sound somewhat resembling the pattering of rain against a window-pane, but higher in pitch and more musical. This sound changed its character very greatly when the direction of the current was reversed, a feeble murmur only being heard. I obtained a similar musical note, though far less loud, with the "mean free-path tube," best when the middle plate was positive. With a tube containing phosphorescent sulphide of calcium, the note was very dull in its quality and low in pitch, but still quite perceptible. With this tube a change in the direction of the current, as might be expected, did not affect the sound produced. I did not obtain this musical note from any tube that I have in which the current enters and leaves by a straight wire, except in the case of a single Geissler's tube exhausted so as to give stratifications, in which it was very feebly heard.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE

A LARGE number of ladies and gentlemen assembled on Tuesday in Cowper Street to witness the laying of the foundation-stone of the Finsbury Technical College which it has lately been resolved to establish by the City and Guilds of London Institute, by His Royal Highness Prince Leopold. According to the report of the Council of the Institute to the Governors, the projected building is estimated to cost 20,382*l.*, exclusive of the professional charges, fittings, and other incidental expenses, which will amount to some 5000*l.* In the plans ample accommodation is provided for instruction in the application of physics, chemistry, and mechanics to the various industries. The building will contain thirty-two rooms, including a large laboratory, two lecture theatres, class, drawing, private, and engine rooms, workshops, and clerks' offices. Lord Selborne, in welcoming the Prince, after noting the progress of science as applied to arts and manufactures in this and other countries, said that in the race of competition the prize must in the end belong to those who best knew how to build the superstructure of arts and manufacture on their handicrafts with a sound foundation of scientific knowledge. The ceremony of laying the stone was gone through by Prince Leopold, who in the course of his remarks said that the institution has proclaimed its determination to enter into generous rivalry with other countries in those branches of trade and commerce in which, one must needs confess, our native industries have of late years not taken that position which we as Englishmen would wish them to occupy. We are beginning to realise that a thorough and liberal system of education must be placed within the reach of the British artisan in order to enable him to hold his own against foreign competition. Mr. Mundella said that by instituting this college they were taking the same step in applying science to industries which had been taken in applying arts to manufactures at South Kensington. Among the articles deposited in the cavity of the foundation-stone was a copy of NATURE.

[1] Read by C. R. Cross at a meeting of the American Academy of Arts and Sciences, November 10, 1880.

THE Berlin correspondent of the *Times* states that a movement is afoot among the Germans in the United States for the creation of a native University on the model of those in the old country, to be called the Kaiser Wilhelm Universität, in commemoration of the "glorious resuscitation of the Fatherland." Milwaukee is mentioned as the likeliest candidate among all the cities of the West that aspire to the honour of harbouring this plant of pure Teutonic culture, which would cost, to begin with, about two million dollars. It is not at all probable, however, that the scheme will come to anything.

SCIENTIFIC SERIALS

THE *Journal of Anatomy and Physiology* for April, 1881 (vol. xv. part 3), contains:—On the bones, articulations, and muscles of the rudimentary hind-limb of the Greenland right whale (*Balæna mysticetus*), by Dr. J. Struthers.—On the stridulating apparatus of *Callomystax gagata*, by Prof. A. C. Haddon (Plate 20).—On the sternum as an index of age and sex, by Dr. Thomas Dwight (concludes that the breast-bone is no trustworthy guide either to the sex or the age).—On the mechanism of costal respiration, by Dr. J. M. Hobson (with figures).—On the membrana propria of the mammary gland, by Dr. C. W. M. Moullin (with figures).—On double and treble staining of microscopical specimens, by Dr. W. Stirling.—On the comparative anatomy of the lymphatics of the mammalian urinary bladder, by Drs. George and F. Elizabeth Hoggan (plate 21).—Notes on a dissection of a case of epispadias, and on the morphology of the muscles of the tongue and pharynx, by Dr. R. J. Anderson. —On the so-called movements of pronation and supination in the hind-limb of certain marsupials, by Dr. A. H. Young.—A contribution to the pathological anatomy of pneumonokoniosis (*Chalicosis pulmonum*), by Thos. Harris (plate 22).—On the histology of some of the rarer forms of malignant bone tumours, by Robt. Maguire.—On the morbid histology of the liver in acute yellow atrophy, by Prof. Dreschfeld.—On the relationship between the muscle and its contraction, by Dr. J. Theodore Cash. —Anatomical notes.

The Quarterly Journal of Microscopical Science, April, 1881, contains—On the minute anatomy of the branchiate echinoderms, by P. Herbert Carpenter (plates 11 and 12).—On young stages of Limnocodium and Geryonia (plate 13), and observations and reflections on the appendages and on the nervous system of *Apus cancriformis*, by E. Ray Lankester (plate 20).—On the origin and significance of the metamorphosis of Actinotrocha, by Edmund B. Wilson (plates 14 and 15).—A further contribution to the minute anatomy of the organ of Jacobson in the guinea-pig (plates 16 and 17), and histological notes, by Dr. E. Klein.—On the development of microscopic organisms occurring in the intestinal canal, by Dr. D. Cunningham (plate 18).—Researches upon the development of starch-grains, by A. F. W. Schimper (plate 19), translated from the *Botanische Zeitung*.—On the cause of the striation of voluntary muscular tissue, by Dr. J. B. Haycraft.—On the relation of micro-organisms to disease, by Prof. Lister; with notes and memoranda.

The American Naturalist, April, 1881.—Wm. Trelease, on the fertilisation of *Salvia splendens* by birds. (The fertilisation is apparently effected by a humming-bird.)—Prof. E. D. Cope, on the origin of the foot-structures of the Ungulates.—C. A. White, progress of invertebrate palæontology in the United States for 1880.—Carl F. Gissler, evidences of the effect of chemico-physical influences on the evolution of branchiopod Crustaceans.—Dr. R. W. Schufeldt, notes on a few of the diseases and injuries of birds.—A. S. Packard, jun., the brain of the locust (with three plates).

Bulletin of the United States Geological and Geographical Survey of the Territories, vol. vi. No. 1.—On the vegetation of the Rocky Mountain region and a comparison with that of other parts of the world, by Asa Gray and Joseph D. Hooker (pp. 1, 77).—On some new Batrachia and Reptilia from the Permian beds of Texas; on a wading bird from the Amyzon shales; on the Nimravidæ and Canidæ of the Miocene period; and on the Vertebrata of the Wind River Eocene beds of Wyoming, by E. D. Cope.—The osteology of *Speotyto cunicularia*, var. *hypogæa*, and on the osteology of *Eremophila alpestris*, by Dr. R. W. Schufeldt.—A preliminary list of the North American species of Agrotis, by A. R. Grote.

Revue internationale des Sciences biologiques, March, 1881.—Prof. Strasburger, the history of the actual state of the cell theory.—M. Debierre, physical and biological dynamism.—Prof. Ray Lankester, embryology and classification of animals.

Brain: a Journal of Neurology.—Part 13 for April, 1881, contains, of original articles:—Dr. J. C. Bucknill, on the late Lord Chief Justice (Sir A. Cockburn) of England.—Dr. B. Bramwell, on the differential diagnosis of paralysis.—Dr. A. Flint, jun., on the cause of the movements of ordinary respiration.—Dr. Julius Althaus, on some points in the diagnosis and treatment of brain disease.—Dr. C. S. W. Cobbold, observations on certain optical illusions of motion.—Bevan Lewis, methods of preparing, demonstrating, and examining cerebral structure in health and disease.

Revue des Sciences Naturelles, 2me série, tome 2, No. 4, March, 1881, contains:—M. A. Salvatier, on the mechanism of respiration in the Chelonians (plates 5 and 6).—Dr. E. Jourdan, notes on the anatomy of *Distomum clavatum*, Rud (plates 7 and 8). — M. A. Villot, another word on the fresh-water Pliocene of the Bas Dauphiné.—M. Collot, provisional study of the Anthracotherium remains from the lignites of Volx.—M. Viguier, note on the lithographic chalks of Nebias.—M. Kieffer, on the herborisations of Strobelberger at Montpellier in 1620 (*finis*).—Scientific review of works published in France on zoology, botany, and geology.

Journal of the Asiatic Society of Bengal, 1880, No. 4 (vol. xlix. Part 2).—W. T. Blanford, contributions to Indian Malacology, No. 12—new land and fresh-water shells from Southern and Western India, Burmah, the Andamans, &c. (plates 2 and 3).—J. Wood Mason and L. de Nicéville, diurnal Lepidoptera from Port Blair, with descriptions of some new or little-known species, and of a new species of Hestia from Burmah (plate 13).—W. T. Blanford, description of an Arvicola (*A. Wynnei*) from the Punjab Himalaya —Capt. G. F. L. Marshall and L. de Nicéville, new species of Rhopalocerous Lepidoptera from the Indian region.—J. Wood Mason, Parantirrhœa Marshalli, the type of a new genus and species of Rhopalocerous Lepidoptera from South India.

Verhandlungen der k. k. zoologisch-botanischen Gesellschaft in Wien, Bd. xxx., Heft 2, 1881, contains the minutes of proceedings, June to December, 1880, and the following memoirs:—F. Krasan, report in connection with new investigations on the development and origin of the lower organisms (plate 7).—Dr. A. v. Krempelhuber, a new contribution to the lichen flora of Australia.—Th. Beling, the metamorphosis of *Cœnomyia ferruginea*, Scop.—Prof. Josef Mik, on the mounting and collecting of Diptera, descriptions of new Diptera, and dipterological notes (plate 17).—H. B. Moschler, contribution to the Lepidopterous fauna of Surinam, No. iii. (plates 8 and 9).—S. Schulzer, mycological contributions.—J. Stussiner, *Leptomastax Simonis*, a new species of subterranean beetle.—Hans Leder, on the Coleopterous fauna of the Caucasus, No. iii., in co-operation with Dr. Eppelsheim and E. Reitter.—D. Hirc, the Molluscan fauna of the Liburnian Karst.—Fritz Wachtl, contribution to our knowledge of the European gall-producing insects (plate 18).—Count E. Keyserling, new American spiders (plate 16).—Dr. Ludwig Lorenz, on *Distomum robustum*, sp. n., from the African elephant (plate 19).—A. von Pelzeln, on a hornless deer.—Dr. F. Löw, on a more exact knowledge of the procreativeness of the sexual individuals in Pemphigus.—Dr. R. Drasche, on a new species of Echiurus from Japan (*E. unicinctus*), and remarks on *Thalessema erythrogrammon*, Leuckart (plate 20).—Dr. R. Bergh, monograph of Polyceridæ (plates 10 to 15).

Gegenbaur's morphologisches Jahrbuch, vol. 17, part 1, contains—Prof. Oscar Herburg, on the exoskeleton of fishes: No. 3, the Pediculati, the Discoboli, the genus Diana, the Centriscidæ, some genera of Triglidæ, and the Plectognathi (plates 1 to 4).—On the duplex nature of the ciliary ganglion, by Prof. W. Krause (plate 5).—On the abdominal muscles of the crocodiles, lizards, and tortoises, by Dr. Hans Gadow (plate 6).—Contributions to the developmental history of Petromyzon, by W. B. Scott (Princeton), (with plates 7 to 11).—On the "pars facialis" of the lachrymal bone, by Prof. Gegenbaur.

Rivista Scientifico-Industriale, No. 6, March 31.—On earthquakes, by Dr. Bassani.—New plant, by S. Fenzi.—Determination of the velocity of sound in chlorine, by Prof. Martini.

Sitzungsberichte der naturforschenden Gesellschaft zu Leipzig, 1879-80.—On double monstrosities in fishes, by Prof. Rauber.—On the finer structure of milk-glands, by the same.—On Aphthæ, by Prof Hennig.—On results of glacier thrust, by Prof. Credner.—On the geological results of a deep boring at the Berlin Railway at Leipzig, by the same.—On the reduction of anatomical forms to equal size, by Prof. Hennig.—On the system of spinal ganglia, by Prof. Rauber.—On chlorophyll, by Dr. Sachsse.—On an optical combination which may be applied as objective of a telescope, by Dr. von Zahn.—On *Lichen bombicinus*, by Prof. Hennig.—On the development of cells to organs of locomotion, by Dr. Simmroth.—On Negrito skeletons from the Philippines in European museums, by Herr Meyer.—On the cycle of forms of some unicellular algæ, by Herr Richter.

Atti della R. Accademia dei Lincei, vol. v. fasc. ix.—On the discharge of condensers, the theory of the electrophorus, and its analogy with condensers, by Prof. Villari.—New observations of Pechüle's comet at the Royal Observatory of the Roman College, by P. Tacchini.—Two solar regions in continuous activity during 1880, by the same.—On the motion of a heterogeneous fluid ellipsoid, by S. Betti.—New method for the volumetric evaluation of molybdenum, by Signors Mauro and Dunesi.—On some compounds of the furfuric series, by Signors Ciamician and Dennstedt.—Separation and determination of nitric and nitrous acid, by S. Piccini.—Observations on the method commonly adopted in treatment of like fundamental questions of infinitesimal analysis, by S. Casorati.—On the drainage works of the Roman subsoil, by S. Tommasi Crudeli.

SOCIETIES AND ACADEMIES

LONDON

Zoological Society, May 3.—Prof. W. H. Flower, LL.D., F.R.S., president, in the chair.—Prof. F. Jeffrey Bell, F.Z.S., read the first of a series of papers on the systematic arrangement of the *Asteroidea*. In the present communication the author directed attention to the large number—more than eighty—of described species of the genus *Asterias*, the subdivision of which had never yet been attempted. After a list of the species with reference to one description of each, and a list of the synonyms, he proceeded to describe and make use of certain characters as an aid in the classification of the species; the number of rays, of madreporiform plates, and of ambulacral spines forming the more important, and the form and character of the spines the less important points. The author then proposed a mode of formulating results by the use of certain symbols, and concluded by describing five new species.—A communication was read from Dr. M. Watson, F.Z.S., containing some observations on the anatomy of the generative organs of the spotted hyæna, in continuation of a previous paper on the same subject.—Mr. Oldfield Thomas, F.Z.S., read a memoir on the Indian species of the genus *Mus*. The present paper was an attempt to clear up the existing confusion in the synonymy of the Indian species of this genus, of which the author recognised about nineteen as valid.—A communication was read from Mr. Edgar A. Smith, containing remarks on some specimens of *Cypræa decipiens*, lately received by the British Museum.—A second paper by Mr. Smith contained the description of two new species of shells from Lake Tanganyika.—Capt. G. E Shelley read a paper containing an account of seven collections of birds recently made by Dr. Kirk in the little explored regions of Eastern Africa. Two new species were proposed to be called *Cocystes albonotatus* and *Urobrachya Zanzibarica*.—Mr. Arthur G. Butler, F.Z.S., read a paper on a collection of Lepidoptera made in Western India, Beloochistan, and Afghanistan by Major Charles Swinhoe. The collection contained examples belonging to three new genera and fifteen new species.

Chemical Society, May 5.—Dr. Roscoe, president, in the chair.—The following papers were read:—On the action of humic acid on atmospheric nitrogen, by E. W. Prevost. The author has repeated some of the experiments of E. Simon (*Land. Vers. Stats*, xviii.) on the above action; he is quite unable to confirm the results of that investigator, and concludes that under ordinary circumstances no formation of ammonia takes place when humic acid and nitrogen are allowed to remain in contact.—On the active and inactive amylamines corresponding to the active and inactive alcohols of fermentation, by R. T. Plimpton. The author has prepared and examined the mono-, di-, and triamylamines and some of their compounds. The active amylamines polarise strongly; their salts do not crystallise so well as those of the inactive amylamines; there is also some difference in the boiling-points and specific gravities of these two classes of bodies.—On the action of sodium alcoholates on fumaric ethers, by T. Purdie. An acid is formed which is an ethylethermalic acid isomeric with the monethylmalate of Desmondisir. The action of sodium isobutylate on isobutyl fumarate was also studied; an isobutylmalic acid was formed.—On the products of the action of alkalies on ethylic β ethylacetosuccinate, by L. T. Thorne. An ethylsuccinic acid was obtained by the action of strong potash identical with that obtained from the α succinate; with weak potash 5 per cent. α-ethyl-β-aceto-propionic acid was obtained, which on boiling gave off water and formed a body $C_7H_{10}O_2$.—On some carbazol compounds, by C. H. Rennie and W. R. Hodgkinson. The authors have studied the action of potassium carbazol on ethyl chlorocarbonate; a new urethane was obtained.

Geological Society, April 27.—R. Etheridge, F.R.S., president, in the chair.—Samuel Gerrard Kirchhoffer, Arthur Henry Shakspere Lucas, and Lieut. Frederick Thomas Nelson Spratt were elected Fellows of the Society. The following communications were read:—On the precise mode of accumulation and derivation of the Moel Tryfan shelly deposits; on the discovery of similar high-level deposits along the eastern slopes of the Welsh mountains; and on the existence of drift-zones showing probable variations in the rate of submergence, by D. Mackintosh, F.G.S.—On the correlation of the Upper Jurassic rocks of England with those of the Continent, by the Rev. J. F. Blake, M.A., F.G.S. Part I. the Paris basin. This was an attempt to settle the many questions of correlation arising out of the detailed descriptions given of the various localities in the Paris basin where Upper Jurassic rocks are developed, by a consecutive survey of them all; undertaken by the aid of a grant from the "Government Fund for Scientific Research." In previous papers the names used for the great sub-divisions and their boundaries were adopted without material modification; in the present such modifications were proposed as may bring the English and Continental arrangements into harmony. Five distinct areas were considered in this paper:—(1)The southern range; (2) the Charentes; (3) Normandy; (4) the Pays de Bray; (5) the Boulonnais. From this study it was proposed—that the "Lower Calcareous grit" and almost all the Coralline oolite should be placed in the Oxfordian series as the upper division, under the name "Oxford Grit" and "Oxford Oolite"; that the Corallian consists of two parts, the Coral Rag and the Supra-coralline beds; that the Kimmeridgian should include the Astartian and Virgulian, the Pterocerian being a subzone; that the "Upper Kimmeridge" and the Hartwell clay, with the "Portland sand," should make a new sub-division to be called Bolonian, the northern and southern types being both represented at Boulogne, which may be divided into upper and lower; and that the true Portland limestone and the Purbeck be united into one group, as Lower and Upper Portlandian; the fact of the latter being freshwater being paralleled by parts of the true Portland having that character.—On fossil chilostomatous Bryozoa from the Yarra-Yarra, Victoria, Australia, by Arthur William Waters, F.G.S.

Anthropological Institute, April 26.—Prof. W. H. Flower, F.R.S., vice-president, in the chair.—Mr. J. E. Price exhibited a collection of bones of man and other animals discovered by himself and Mr. Hilton Price at the Roman villa at Brading, Isle of Wight. The bones had been examined by Prof. Flower, who reported that they were all in much the same state of preservation, and probably all contemporaneous. They consisted of (1) Man: fragments probably of one and the same skeleton. From the condition of the bones it is certain that the individual was adult and probably of middle age and about the average stature. (2) Dog: Numerous remains of at least three individuals, all of nearly the same age and size, not more than half-grown, having only the milk teeth in place. (3) Ox: Young. (4) Horse: One incisor tooth.—Mr. A. L. Lewis read a paper on some archaic structures in Somersetshire and Dorsetshire. The author, in speaking of the great stone circles at Stanton Drew, near Bristol, mentioned the elaborate astronomical theories which had been propounded concerning them by antiquaries of the last century, and said that, while he had no belief in them, he thought that the larger stone circles, of which this group was a specimen, had been used as places for solar worship; there was in nearly all of them some special reference to the north-east, the quarter in which the sun rose on the longest day; in some, however, there were outlying stones towards the south, and this was the case at a circle at Gorwell in Dorsetshire; these stones, whether to the south or the north-east, were evidently so placed for some special object, as the number of instances in which they occurred was too great for their position to be merely accidental. The paper was illustrated by the exhibition of plan, model, and some worked flints, &c., found by the author at some of the monuments mentioned by him.—Mr. G. M. Atkinson read a paper on a new instrument for determining the facial angle. A needle is inserted into each optic foramen, and fixed at a point in the centre of each orbit; the needles are connected by an axle with flat ends which slide on the needles; an index-pointer is attached to the axle in the middle, and is in the same visual horizontal plane as the needles. A bar, carrying a semicircular protractor, is constructed to be affixed at the centre-point of the protractor, and to have free movement in a vertical plane alongside the index-pointer. If this bar-protractor be placed in position on the skull so as to touch the ophryon and alveolar points, the number of degrees in the facial angle, by this method, will be indicated by the index-pointer on the protractor.—The Rev. W. S. Caiger read a paper on Thomas of Aquinum and anthropology.

Royal Microscopical Society, April 13.—Prof. P. Martin Duncan, F.R.S., president, in the chair.—A paper by Mr. W. H. Shrubsole and Mr. F. Kitton, on the diatoms discovered by the former in the London clay, was read. Also one by Dr. Anthony, on sliding stage diaphragms.—The other subjects discussed were E. Hallier's view of the cause of the movements of diatoms, the "Society" standard screw, *Amphipleura pellucida* illuminated by the vertical illuminator, and the structure of wood-sections exhibited by Mr. Stewart.—Mr. Powell exhibited an oil-immersion $\frac{1}{8}$-inch objective of the exceptionally large aperture of 1·47 N.A. (1·0 = 180° in air).

EDINBURGH

Royal Society, April 17.—Sir William Thomson, honorary vice-president, in the chair.—Prof. Helmholtz, in an interesting communication on electrolytic conduction, stated that the experiments he was about to describe were a continuation of experiments he had formerly made in connection with certain objections that had been urged against Faraday's law of electrolysis. He had already shown that a feeble galvanic current could be passed through an electrolytic preparation of acidulated water, even though the electromotive force was not sufficient to decompose the water. The action of such a current would be, in the first place, to coat the electrodes, the one with hydrogen, the other with oxygen. The hydrogen however speedily combined with the free oxygen in the air and liquid to form water, while the oxygen on the positive electrode as speedily dissipated itself. In this way the polarisation in the electrolytic cell was kept down, so that the original current was never wholly destroyed. In the later experiments Prof. Helmholtz had completely removed the air from the neighbourhood of the electrolyte. This was effected by an ingenious use of the property possessed by palladium of holding large quantities of hydrogen gas in its pores. With this specially-prepared cell he found that a feeble current passed through it fell down to zero in a very short time, the difference of potential due to the polarisation of the electrodes quite balancing the original electromotive force. On throwing off the battery the polarised electrolytic cell showed on a delicate galvanometer a reversed current, which rapidly fell to zero from an intensity equal to that of the original current before polarisation set in. Another result to which his researches had led him was that there were no *chemical* forces acting between the molecules of an electrolyte other than those that existed in virtue of what might be called their electric charges—a result which cannot fail to have an important bearing upon the question of chemical constitution.—Sir William Thomson communicated a short paper on the average pressure due to impulse of vortex-rings on a solid. When a vortex-ring is approaching a plane large in comparison to the dimensions of the ring, the total pressure over the surface is *nil*. When a ring approaches such a surface it begins to expand, so that if we consider a finite portion of the surface the total pressure upon it due to the ring will have a finite value when the ring is close enough. In a closed cylinder any vortex-ring approaching the plane end will expand out along the surface, losing in speed as it so does, until it reaches the cylindrical boundary, along which it will crawl back, on rebounding, to the other end of the cylinder. As it approaches, it will therefore exert upon the plane surface a definite outward pressure, whose time-integral is equal to the original momentum of the vortex, and a precisely equal pressure as it leaves the surface. Hence, in the case of myriads of vortex-rings bombarding such a plane surface, though no individual vortex-ring leaves the surface immediately after collision, for every vortex-ring that gets entangled in the condensed layer of drawn-out vortex-rings another will get free, so that in the statistics of vortex-impacts the pressure exerted by a gas composed of vortex-atoms is exactly the same as is given by the ordinary kinetic theory, which regards the atoms as hard elastic particles.—Prof. Tait, in a brief paper on the crushing of glass by pressure, indicated certain results he had obtained by experiments, which were in good accord with the mathematical theory of the strains to which a closed cylindrical glass tube under high pressure is subjected. Of the three stresses, radial, tangential, and longitudinal, which may be regarded as acting upon any elementary portion of the wall of the tube, the two former have a *shearing* effect, to which the crushing of the tube is due. From the few experiments that had been completed it appeared that the shear required to disintegrate ordinary lead glass was about $1 \pm \frac{1}{20}$.—Prof. J. Blyth gave an account of experiments which he had made on the cause of the sounds produced in the microphone receiver. He also exhibited another form of telephone, in which the vibrating membrane was attached rigidly to a copper wire dipping into a column of mercury which formed along with the wire part of the circuit. The inductive effect of the current on itself caused the wire and the attached membrane to vibrate in exact correspondence with the variations of the current.

Paris

Academy of Sciences, May 2.—M. Wurtz in the chair.—The following papers were read:—Note on a property of the indicatrix, relative to the mean curvature of convex surfaces, by M. Faye.—On the inverse electromotive force of the voltaic arc, by M. Jamin. With a continuous battery current this inverse force presents a resistance to be first overcome; but with alternately contrary currents from a magneto-machine renewed at least 500 times per second, the current at each inversion profits momentarily by the inverse force called forth during the previous emission. Hence the possibility of lighting several arcs in the same circuit of a machine (and the number increases rapidly with the velocity).—Formation of a marine zoological station in the Eastern Pyrenees, by M. de Lacaze-Duthiers. Some proposed harbour alterations at Port Vendres led the author to look about for another suitable locality. Banyuls-sur-Mer made prompt application, with generous offers of help in the case of being chosen. The Port Vendres authorities were also urgent. At Perpignan the project was cordially received. Thus promises have been made of a capital of 32,000 francs, an annual sum of 750 francs, a site, a boat, and the product of a subscription. The President expressed the satisfaction of the Academy.—The derangements of progression, of station, and of equilibration arising in experiments on the semicircular canals or in maladies of these canals, are not the effects of these, but of the influence they have on the cerebellum; note by M. Bouillaud.—On the inequalities with long periods in the movements of heavenly bodies, by M. Gyldén.—On the stratigraphic series of rocks which form the ground in Upper Auvergne, by M. Fouqué. Apart from unimportant flows of Miocene basalt the series of volcanic rocks there comprises two distinct periods, both commencing with strong projections and eruptions of trachytic and acid Andesitic rocks, and terminating with very basic eruptions, porphyroid basalt and basalt of plateaux.—Examination of some artificial products obtained by James Hall, by MM. Fouqué and Lévy. Living in the end of last century, he seems to have been the first who artificially reproduced an eruptive crystalline rock (viz., whinstone).—On salicylic acid and its applications, by M. Schlumberger. *Inter alia*, it has been given daily to animals in some places for years as a protective against contagious disease. To preserve beer it is introduced twice, the first dose being only sufficient to act on lactic ferments, not yeast; a second dose prevents the alcoholic degenerating into acetic fermentation. The two doses together amount to not more than $\frac{1}{20000}$ or 0·05 gr. per litre. It is estimated that 5,000,000 hectolitres of wine were salicylised in France in 1880.—Observations of the comet *f* 1880 (Pechüle) at Paris Observatory, by M. Bigourdan.—On the principle of conservation of electricity, or second principle of the theory of electric phenomena, by M. Lippmann. The algebraic sum of all the simultaneous variations of charge is always nil. Hence the sum of the quantities of free electricity is invariable, since its total variation is always equal to zero. This law extends to all the phenomena hitherto studied. M. Lippmann translates it into analytical language.—On the protobromide and protoiodide of chromium, and on the oxalate and protoxide of chromium, by M. Moissan.—On the acetylic derivatives of cellulose, by M. Franchimont.—Action of sulphuric acid on acetic anhydride, by the same.—On a reagent fitted to distinguish ptomaïnes from vegetable alkaloids, by MM. Brouardel and Boutmy. This reagent is ferricyanide of potassium, which, in presence of pure organic bases produced in the laboratory or extracted from a body after alleged poisoning, is not any way modified, but when brought into contact with ptomaïnes (cadaveric alkalies) is changed at once to ferrocyanide, and then becomes capable of forming prussian blue with salts of iron.—On a combination of iodoform and strychnine, by M. Lextrait.—On some felspars of the valley of Bagnères-de-Luchon (Haute-Garonne), by M. Filhol.—On the physiological and pharmaco-therapic effects of inhalation of oxygen, by M. Hayem. Inhalation of oxygen is a useful auxiliary to treatment of chlorosis with iron. The action is similar to that of hydrotherapy, which stimulates the nutritive movement and the formation of red corpuscles, without sensibly modifying the individual alterations of these elements. The method effectually suppresses vomiting when not caused by organic lesion of the stomach.—On an approaching scientific voyage to the whale fishery of Vadsö, by M. Pouchet. Vadsö is on the east coast of Finmark. A steam advice-boat, *Le Coligny*, has been placed at M. Pouchet's disposal by Government. The marine fauna and flora and the rocks of the Varanger fiord will be studied, and certain questions in the biology of fishes especially.—Migration of the puceron of the poplar (*Pemphigus bursarius*, Lin.), by M. Lichtenstein.—Trichinæ encysted in the intestinal walls of the pig, by M. Chatin.—Study on some points of the anatomy of *Sternaspis scutata*, by M. Rietsch.—On two meteors observed at Nouvion-en-Thierache, by M. Baudrin.

Vienna

Imperial Academy of Sciences, May 5.—L. Fitzinger in the chair.—The following papers were read:—F. Steindachner, contributions to the knowledge of the river fishes of South America, Part iii.; ichthyological contributions, Part xi., by the same.—Dr. Karl Richter, contributions to a precise knowledge of cell-membranes of the fungi.—Dr. R. Benedikt and v. Hübl, on dinitro- and trinitroresorcin.—K. Fischer, on the salts of resorcinsulphonic acid.—Prof. H. Durège, on bodies (figures) of four dimensions.—A. Brezina, on the meteor-iron of Bolson de Mapimi.—Dr. T. Domac, on hexylene of mannite.—Prof. Stefan, on the evaporation at a circular or elliptical basin.—T. Holetschek, computation of the orbit of the "Peitho" planet (*ii* 8), discovered in 1872 by Dr. R. Luther at Düsseldorf.—Dr. H. Seeliger, on the ratio of motion in the asterism of ζ Cancri.

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