Nature. Vol. X, No. 242 June 18, 1874

London: Macmillan Journals, June 18, 1874

https://digital.library.wisc.edu/1711.dl/LBXITYVRTMAPI83

PLATEAU ON SOAP-BUBBLES

Statique expérimentale et théorique des Liquides soumis aux seules Forces moléculaires. Par J. Plateau, Professeur à l'Université de Gand, &c. (Paris, Gauthier-Villars; London, Trübner & Co.; Gand et Leipzig, F. Clemm. 1873.)

ON an Etruscan vase in the Louvre figures of children are seen blowing bubbles. Those children probably enjoyed their occupation just as modern children do. Our admiration of the beautiful and delicate forms, growing and developing themselves, the feeling that it is *our* breath which is turning dirty soap-suds into spheres of splendour, the fear lest by an irreverent touch we may cause the gorgeous vision to vanish with a sputter of soapy water in our eyes, our wistful gaze as we watch the perfected bubble when it sails away from the pipe's mouth to join, somewhere in the sky, all the other beautiful things that have vanished before it, assure us that, whatever our nominal age may be, we are of the same family as those Etruscan children.

Here, for instance, we have a book, in two volumes, octavo, written by a distinguished man of science, and occupied for the most part with the theory and practice of bubble-blowing. Can the poetry of bubbles survive this? Will not the lovely visions which have floated before the eyes of untold generations collapse at the rude touch of Science, and "yield their place to cold material laws"? No, we need go no further than this book and its author to learn that the beauty and mystery of natural phenomena may make such an impression on a fresh and open mind that no physical obstacle can ever check the course of thought and study which it has once called forth.

M. Plateau in all his researches seems to have selected for his study those phenomena which exhibit some remarkable beauty of form or colour. In the zeal with which he devoted himself to the investigation of the laws of the subjective impressions of colour, he exposed his eyes to an excess of light, and has ever since been blind. But in spite of this great loss he has continued for many years to carry on experiments such as those described in this book, on the forms of liquid masses and films, which he himself can never either see or handle, but from which he gathers the materials of science as they are furnished to him by the hands, eyes, and minds of devoted friends.

So perfect has been the co-operation with which these experiments have been carried out, that there is hardly a single expression in the book to indicate that the measures which he took and the colours with which he was charmed were observed by him, not in the ordinary way, but through the mediation of other persons.

Which, now, is the more poetical idea—the Etruscan boy blowing bubbles for himself, or the blind man of science teaching his friends how to blow them, and making out by a tedious process of question and answer the conditions of the forms and tints which he can never see?

But we must now attempt to follow our author as he passes from phenomena to ideas, from experiment to theory.

The surface which forms the boundary between a liquid and its vapour is the seat of phenomena on the careful study of which depends much of our future progress in the knowledge of the constitution of bodies. To take the simplest case, that of a liquid, say water, placed in a vessel which it does not fill, but which contains nothing else. The water lies at the bottom of the vessel, and the upper part, originally empty, becomes rapidly filled with the vapour of water. The temperature and the pressure—the quantities on which the thermal and statical relations of any body to external bodies depend—are the same for the water and its vapour, but the energy of a milligramme of the vapour greatly exceeds that of a milligramme of the water. Hence the energy of a milligramme of water-substance is much greater when it happens to be in the upper part of the vessel in the state of vapour, than when it happens to be in the lower part of the vessel in the state of water.

Now we find by experiment that there is no difference between the phenomena in one part of the liquid and those in another part except in a region close to the surface and not more than a thousandth or perhaps a millionth of a millimetre thick. In the vapour also, everything is the same, except perhaps in a very thin stratum close to the surface. The change in the value of the energy takes place in the very narrow region between water and vapour. Hence the energy of a milligramme of water is the same all through the mass of the water except in a thin stratum close to the surface, where it is somewhat greater; and the energy of a milligramme of vapour is the same all through the mass of vapour except close to the surface, where it is probably less.

The whole energy of the water is therefore, in the first place, that due to so many milligrammes of water; but besides this, since the water close to the surface has an excess of energy, a correction, depending on this excess, must be added. Thus we have, besides the energy of the water reckoned per milligramme, an additional energy to be reckoned per square millimetre of surface.

The energy of the vapour may be calculated in the same way at so much per milligramme, with a deduction of so much per square millimetre of surface. The quantity of vapour, however, which lies within the region in which the energy is beginning to change its value is so small that this deduction per square millimetre is always much smaller than the addition which has to be made on account of the liquid. Hence the whole energy of the system may be divided into three parts, one proportional to the mass of liquid, one to the mass of vapour, and the third proportional to the area of the surface which separates the liquid from the vapour.

If the system is displaced by an external agent in such a way that the area of the surface of the liquid is increased, the energy of the system is increased, and the only source of this increase of energy is the work done by the external agent. There is therefore a resistance to any motion which causes the extension of the surface of a liquid.

On the other hand, if the liquid moves in such a way that its surface diminishes, the energy of the system diminishes, and the diminution of energy appears in the form of work done on the external agent which allows the surface to diminish. Now a surface which tends to diminish in area, and which thus tends to draw together any solid framework which forms its boundary, is said to have surface-tension. Surface-tension is measured by the force acting on one millimetre of the boundary edge. In the case of water at 20° C., the tension is, according to M. Quincke, a force of 8·253 milligrammes weight per millimetre.

M. Plateau hardly enters into the theoretical deduction of the surface-tension from hypotheses respecting the constitution of bodies. We have therefore thought it desirable to point out how the fact of surface-tension may be deduced from the known fact that there is a difference in energy between a liquid and its vapour, combined with the hypothesis, that as a milligramme of the substance passes from the state of a liquid within the liquid mass, to that of a vapour outside it, the change of its energy takes place, not instantaneously, but in a continuous manner.

M. van der Waals, whose academic thesis, "Over de Continuiteit van den Gas- en Vloeistoftoestand,"* is a most valuable contribution to molecular physics, has attempted to calculate approximately the thickness of the stratum within which this continuous change of energy is accomplished, and finds it for water about 0·0000003 millimetre.

Whatever we may think of these calculations, it is at least manifest that the only path in which we may hope to arrive at a knowledge of the size of the molecules of ordinary matter is to be traced among those phenomena which come into prominence when the dimensions of bodies are greatly reduced, as in the superficial layer of a liquid.

But it is in the experimental investigation of the effects of surface-tension on the form of the surface of a liquid that the value of M. Plateau's book is to be found. He uses two distinct methods. In the first he prepares a mixture of alcohol and water which has the same density as olive oil, then introducing some oil into the mixture and waiting till it has, by absorption of a small portion of alcohol into itself, become accommodated to its position, he obtains a mass of oil no longer under the action of gravity, but subject only to the surface-tension of its boundary. Its form is therefore, when undisturbed, spherical, but by means of rings, disks, &c., of iron, he draws out or compresses his mass of oil into a number of different figures, the equilibrium and stability of which are here investigated, both experimentally and theoretically.

The other method is the old one of blowing soap-bubbles. M. Plateau, however, has improved the art, first by finding out the best kind of soap and the best proportion of water, and then by mixing his soapy water with glycerine Bubbles formed of this liquid will last for hours, and even days.

By forming a frame of iron wire and dipping it into this liquid he forms a film, the figure of which is that of the surface of minimum area which has the frame for its boundary This is the case when the air is free on both sides of the film. If, however, the portions of air on the two sides of the film are not in continuous communication, the film is no longer the surface of absolute minimum area, but the surface which, with the given boundary, and enclosing a given volume, has a minimum area.

M. Plateau has gone at great length into the interesting but difficult question of the conditions of the persistence of liquid films. He shows that the surface of certain liquids has a species of viscosity distinct from the interior viscosity of the mass. This surface-viscosity is very remarkable in a solution of saponine. There can be no doubt that a property of this kind plays an important part in determining the persistence or collapse of liquid films. M. Plateau, however, considers that one of the agents of destruction is the surface-tension, and that the persistence mainly depends on the degree in which the surface-viscosity counteracts the surface-tension. It is plain, however, that it is rather the inequality of the surface-tension than the surface-tension itself which acts as a destroying force.

It has not yet been experimentally ascertained whether the tension varies according to the thickness of the film. The variation of tension is certainly insensible in those cases which have been observed.

If, as the theory seems to indicate, the tension diminishes when the thickness of the film diminishes, the film must be unstable, and its actual persistence would be unaccountable. On the other hand, the theory has not as yet been able to account for the tension increasing as the thickness diminishes.

One of the most remarkable phenomena of liquid films is undoubtedly the formation of the black spots, which were described in 1672 by Hooke, under the name of holes.

Fusinieri has given a very exact account of this phenomenon as he observed it in a vertical film protected from currents of air. As the film becomes thinner, owing to the gradual descent of the liquid of which it is formed, certain portions become thinner than the rest, and begin to show the colours of thin plates. These little spots of colour immediately begin to ascend, dragging after them a sort of train like the tail of a tadpole. These tadpoles, as Fusinieri calls them, soon begin to accumulate near the top of the film, and to range themselves in horizontal bands according to their colours, those which have the colour corresponding to the smallest thickness ascending highest.

In this way the colours become arranged in horizontal bands in beautiful gradation, exhibiting all the colours of Newton's scale. When the frame of the film is made to oscillate, these bands oscillate like the strata formed by a series of liquids of different densities. This shows that the film is subject to dynamical conditions similar to those of such a liquid system. The liquid is subject to the condition that the volume of each portion of it is invariable, and the motion arises from the fact that by the descent of the denser portions (which is necessarily accompanied by the rise of the rarer portions) the gravitational potential energy of the system is diminished. In the case of the film, the condition which determines that the descent of the thicker portions shall entail the rise of the thinner portions must be that each portion of the film offers a special resistance to an increase or diminution of area This resistance probably forms a large part of the superficial viscosity investigated by M. Plateau, which retards the motion of his magnetic needle, and evidently is far greater than the viscosity of figure, in virtue of which the film resists a shearing motion.

The coloured bands gradually descend from the top of the film, presenting at first a continuous gradation of

* Leiden, A. W. Sijthoff, 1873.

colour, but soon a remarkable black, or nearly black, band begins to form at the top of the film, and gradually to extend itself downwards. The lower boundary of this black band is sharply defined. There is not a continuous gradation of colour according to the arrangement in Newton's table, but the black appears in immediate contact with the white or even the yellow of the first order, and M. Fusinieri has even observed it in contact with bands of the third order.

Nothing can show more distinctly that there is some remarkable change in the physical properties of the film, when it is of a thickness somewhat greater than that of the black portion. And in fact the black part of the film is in many other respects different from the rest. It is easy, as Leidenfrost tells us, to pass a solid point through the thicker part of the film, and to withdraw it, without bursting the film, but if anything touches the black part, the film is shattered at once. The black portion does not appear to possess the mobility which is so apparent in the coloured parts. It behaves more like a brittle solid, such as a Prince Rupert's drop, than a fluid. Its edges are often very irregular, and when the curvature of the film is made to vary, the black portions sometimes seem to resist the change, so that their surface has no longer the same continuous curvature as the rest of the bubble. We have thus numerous indications of the great assistance which molecular science is likely to derive from the study of liquid films of extreme tenuity.

We have no time or inclination to discuss M. Plateau's work in a critical spirit. The directions for making the experiments are very precise, and if sometimes they appear tedious on account of repetitions, we must remember that it is by words, and words alone, that the author can learn the details of the experiment which he is performing by means of the hands of his friends, and that the repetition of phrases must in his case take the place of the ordinary routine of a careful experimenter. The description of the results of mathematical investigation, which is a most difficult but at the same time most useful species of literary composition, is a notable feature of this book, and could hardly be better done. The mathematical researches of Lindelöf, Lamarle, Scherk, Riemann, &c., on surfaces of minimum area, deserve to be known to others besides professed mathematicians, and M. Plateau deserves our thanks for giving us an intelligible account of them, and still more for showing us how to make them visible with his improved soap-suds.

In the speculative part of the book, where the author treats of the causes of the phenomena, there is of course more room for improvement, as there always must be when a physicist is pushing his way into the unknown regions of molecular science. In such matters everything human, at least in our century, must be very imperfect, but for the same reason any real progress, however small, is of the greater value.

J. CLERK MAXWELL

HINTON'S PRACTICAL PHYSIOLOGY

Physiology for Practical Use. By various writers. Edited by James Hinton. 2 vols. (Henry S. King & Co.)

THIS work consists of a series of independent essays by different writers, on points in physiology which are likely to prove interesting and instructive to the general public. No attempt is made to give more than the best known facts of the science, together with the most approved theories by which they are, at the present day, connected. The thoroughness of the knowledge of the authors, the largeness of the view they take of the subject, and the easiness of the style they adopt add greatly to the interest of the book.

Those who are accustomed to regard the living body as an arrangement of organs which is quite peculiar and whose mechanism is altogether inexplicable upon the ordinary principles of mechanics and chemistry, will, after having carefully studied this work, be convinced how subject it is to the same influences that affect the inanimate world, and that in fact it is nothing more than a very complex machine, with the detailed mechanism of which we are daily becoming more and more acquainted. There are peculiarities however in the living frame which fail to be represented in working out the analogy with the steam engine. "The latter, after being constructed, daily wastes. Every day it becomes worse, for each stroke of its piston, to say nothing of the motion of its other parts, implies a waste of the piston itself, and of the cylinder in which it is inclosed, and in which it works. Now when we get these out of order, the whole machine has to be stopped, that the engineer may repair the deteriorated portions." Such is not the case in the living body, which differs from any machine yet constructed in that it is "constantly working, constantly wasting, and *constantly repairing its own deficiencies.*" This is a most important difference between the two engines; and it is almost certain, that as our knowledge of machine-construction increases, but little improvement will ever be made in this direction, on account of the nature of the materials employed, so that the difference will not be diminished. The cell of a Daniel's battery may be instanced as an example of an engine in which a partial repair of its structure is continually being effected, for by the gradual solution of the crystals of sulphate of copper that are always placed in one of the compartments, the power of the battery, and therefore the constancy of the current it developes, is rendered more perfect.

There is an excellent chapter on alcohol, in which the principle of its action is most clearly explained. The author prefaces his subject by clearly stating his views on its social relations. For instance, he remarks:—"We are not in the ranks of those who would remove the tax on spirits, a tax whereby the poor as well as the rich are made to contribute to the expenses of Government, by paying a price above its production-cost for an article of luxury; and very far are we from siding with those who misinterpret the liberty of the subject—we mean the right of any man to wrong his neighbour, to sell him fictitious goods—poison, perchance for food." "We are not abstainers ourselves, and we are not about to advocate teetotalism under the banner of physiological instruction."

There is a paragraph which quite represents the generally accepted doctrine of the relation of mental activity to work done, but to which we think all physiologists ought now-a-days to take exception. It is remarked that "energy, the manifestation of power, or the conversion of force into action, involves no expenditure of life or loss of power. Thinking or lifting a weight is but a function of tissues provided to issue thoughts or actions. The tissues do not suffer by reason of their employment, so long as their nutrition is maintained. Brain and muscle can be very fairly likened to machinery." From this it is evident that the author considers that both mental and muscular activity involve a consumption of nutriment material according to their amount. Of muscular action this is no doubt correct, for the amount of work performed can be measured by foot-pounds without difficulty; but as it is inconceivable that we should be able to say that one pound falling through one foot is equivalent to so much thought, or so much of an argument, not because of the difficulty in measuring, but because of the total absence of relation between the one and the other; so it is necessary to believe that thought is not a mode of motion, is not capable of being correlated with the other physical forces, and does not involve the consumption of nutrient fluid. If the brains of different individuals are compared to running streams, in which the waters exhibit different degrees of clearness, as brains give evidences of differences in quality, their thoughts may be compared to the reflections of surrounding objects on the surfaces of the streams, different in intensity according to the clearness of the water or the quality of the brain cells. Upon this analogy it is evident that the relative intensity of different reflections is not dependent at all on the stream itself, but on the illuminating power of the objects reflected; in like manner we cannot conceive that the amount of nerve tissue disintegrated by the greatest minds at the time that they are evolving their mightiest thoughts is in excess of that which is wasted during the same time by the most commonplace member of every community. Thought is as intimately connected with the reception of external impressions by the healthy human brain as reflections from water are with the illumination of the surrounding objects; they are involuntary when cause for their development is present.

The chapters on headache and on sleep are amongst those which show how backward is our knowledge of some of the simplest of the phenomena of life. We may be able to recognise that "sick headache" and nightmare have something to do with the presence of indigestible matter in the stomach, but as to the true relation between the two we are still completely in the dark. In speaking of "taking cold" the author tells us that "cold contracts almost all substances, and when the skin is exposed to its influence the contraction becomes visible to the eye, and the appearance it presents is called *goose-skin*, from its resemblance to the natural condition of the skin of the goose." This will, we fear, mislead those readers who are pure physicists as to what is the index of expansion of skin for heat, the fact being that the cold, by stimulating the small arteries of the corium, causes them to contract, and so prevents the blood from entering its substance, which gives it the shrunken, plucked-bird-like appearance that it presents. We are told also that "no danger need ever be apprehended from the application of cold water to the naked body, if it be made immediately after remaining some time exposed to a high temperature." With this it is difficult to agree, for the epistaxis, or nose-bleeding, which sometimes occurs on entering the cold plunge of the Turkish bath shows that the blood-pressure is thereby suddenly augmented to a degree which cannot but be dangerous in some cases, especially when the walls of the arterial system are not as strong as they might be.

In conclusion we strongly recommend this work to non-professional readers, from the lucid and logical manner in which the physiological problems of everyday life are stated. The public cannot be too forcibly impressed with the importance of removing causes rather than combating effects by direct means, and on these points the authors lay considerable stress. The principles of such subjects as ventilation and gymnastics cannot be too frequently taught, and when expounded by writers so capable as those of the work before us they are doubly impressive.

OUR BOOK SHELF

Annual Record of Science and Industry for 1873. Edited by Spencer F Baird, with the assistance of eminent men of Science.—(New York: Harper and Brothers, 1874.)

The Year Book of Facts in Science and Art: exhibiting the most important discoveries of the past year. By John Timbs.—(London: Lockwood and Co., 1874.)

THESE books, like M. Figuier's "L'Année scientifique,' give a fair general idea of the progress of Science and the mechanical arts during the year. They are scarcely sufficiently comprehensive and exact for the man of Science, but are decidedly useful for the ordinary well-educated reader, who takes an interest in the discoveries of Science. Mr. Baird's book is perhaps something more than this: it is carefully arranged, and enters into detail in most cases; it is also preceded by a "General Summary of Scientific Progress," of somewhat more than a hundred pages. From this we learn that five new planets were discovered during 1873—the last "Sophrosyne" being the 134th in order, starting from "Ceres," which was discovered in 1801. Seven comets were seen during last year, three of them new ones; five out of the seven were first seen in Marseilles by those indefatigable observers, Stephan, Coggia, and Borelli. In Physics there appears to have been no discovery of any particular note. In Chemistry the copper-zinc couple of Dr. Gladstone and Mr. Tribe, and its results are described as among the most interesting work of the year. Further on we find an account of the cruise of the *Challenger*, and favourable mention of Sir William Thomson's suggestions that steel pianoforte-wire should be used for a sounding line in place of the usual hempen cord, which offers far greater resistance, and requires a heavy weight at the bottom. Under the head of "Mechanics and Engineering," we find some interesting statistics of American iron-industry. The production of pig-iron in the United States is estimated (for 1873) at 2,406,637 gross tons. The total number of furnaces is 636, and their estimated capacity 4,371,277 net tons. There are eight Bessemer works in the country, with a total capacity of 170,000 tons. The great Hoosac tunnel, 4¾ miles long, was completed during the year. In Timbs' "Year Book" we find too many evidences of careless compilation, and great want of method in grouping the different subjects. We read, "Dr. Odling, President of the Chemical Society, read a paper On the preparation of the Standard Trial plates to be used in verifying the composition of the coinage:"—the paper was by Mr. Roberts, not Dr. Odling. Among the so-called chemical subjects, we find "Sunlight for the sick," "Transparent paper," and "Opium-smoking in New York." It is unfortunate also that non-scientific journals are so often made to guarantee scientific facts.

The *Illustrated London News* is quoted, and the *Hampshire Telegraph* is made to paraphrase the *Philosophical Magazine*.

Reprint of Boddaert's Table des Planches Enluminéez d'Histoire Naturelle. Edited by W. B. Tegetmeier, F.Z.S.

MR. TEGETMEIER has done a service to ornithology by increasing the facilities for precise avian nomenclature, in reprinting, with an accuracy in typography which does him much credit, a catalogue compiled by Dr. Boddaert, printed in 1783, which contains the names of a large number of birds, given on the then novel binomial system of Linnæus. The original work is extremely scarce, only two copies being known in the United Kingdom; and as so much stress has to be laid on priority in naming, a book published so soon after the tenth edition of the "Systema Naturæ" ought to be available to all working ornithologists.

LETTERS TO THE EDITOR

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. No notice is taken of anonymous communications.*]

Molecular Motion

IN Prof. Maxwell's communication, NATURE, vol. viii., p. 537, on this subject, he assumes that if n_1 represent the number of molecules of a particular kind in a given element of space with a velocity given in direction and magnitude, which we will call v_1; and if n_2 represent the particles of another kind in the same element with the velocity v_2, then the number of encounters of these particles is proportional to $n_1 \times n_2$, and if out of these we select the particular encounters which give rise to a given set of resultant velocities v_1' and v_2', then we may assume that if the number of particles in the element which originally had the velocities v_1' and v_2' be called n_1' and n_2', then

$$n_1 n_2 = n_1' n_2'$$

This reasoning does not seem convincing. Assuming that in an element of space the average number of particles having a given velocity is the same, so that n_1 and n_2 are *not* functions of v_1 and v_2, then Mr. Maxwell's statement might be admitted; but if the number of particles in a given element is a function of its velocity in direction and magnitude, then although the average of the numbers in each direction is maintained, it does not follow that the average numbers of particles having the velocities v_1 and v_2 are directly restored from the particles having the velocities v_1' and v_2'. All that can be assumed is, that the average number of particles in a given element of space is maintained from the particles in that and the remaining elements. Just as in the case of an equilibrium of trade, the average course of exchange with respect to a given country is at par; but we cannot therefore safely assume that the same is the case relatively to any other individual country.

There are several other points in Mr. Maxwell's communication which seem to me to require fortification, but the subject has already assumed so technical a form that it would perhaps be uninteresting to your readers to point them out. My impression is that the whole subject is still somewhat beyond the grasp of strict mathematical reasoning, and is still open to experimental investigation.

F. GUTHRIE

Graaff Reinet College, Feb. 7

[This question is treated at length in my paper On the dynamical theory of gases (Phil. Trans., 1866). It is there shown that if the average course of exchange is in a cycle from A to B, B to C, C to A, an equal reason may be given why it should be in the opposite cycle A to C, C to B, B to A., and thus it is shown that the exchange is at par between each pair of states separately. For a far more elaborate theoretical treatment of the subject Prof. Guthrie is referred to the papers of Prof. Ludwig Boltzmann in the Vienna Transactions since 1868. I fear we must delay the experimental investigation for some time, till we are able to count the molecules in a given space, to observe their velocities, and to repeat these operations millions of times in a second.—J. CLERK MAXWELL.]

The Germans and Physical Axioms

ALTHOUGH the *à priori* origin of the fundamental principles of Mechanics has been lucidly demonstrated by the reasoning of Herbert Spencer, it is presumable that his antagonists, who evidently pay great deference to authority, will not be convinced of its truth except by the opposition of acknowledged authorities. Kant, in Germany, one of the first and most assiduous students of Newton's *Principia*, from which he derived the nebular hypothesis subsequently developed by Laplace, thus delivers himself respecting the matter under discussion:—

"The science of Natural Philosophy (Physics) contains in itself synthetical judgments *à priori as principles*. For instance, the proposition, 'in all changes of the material world, the quantity of matter remains unchanged;' or, that 'in all communication of motion, action and reaction must always be equal.' In both of these, not only is the *necessity, and therefore their origin à priori clear*. And so it is with regard to the other propositions of the pure part of Natural Philosophy."—"Critique of Pure Reason," Bohn's edition, page 11 of Introduction:—

This is explicit and incontrovertible. Yet those with whom precedents are omnipotent may argue that, since Kant was pre-eminent as a metaphysician rather than as a physicist, his deliverances must fall before the contrariety of such a man as Prof. Tait. Read then, the declaration of Helmholz:—

"In mathematics the general propositions which, under the name of axioms, stand at the head of the reasoning, are so few in number, so comprehensive, and so immediately obvious, that no proof whatever is needed for them. Let me remind you that the whole of algebra and arithmetic is developed out of the three axioms—

'Things which are equal to the same things are equal to one another.'

'If equals be added to equals, the wholes are equal.'

'If unequals be added to equals, the wholes are unequal.'

"And the axioms of geometry and *mechanics* are not more numerous. The sciences we have named are developed out of these few axioms by a continual process of deduction from them in more and more complicated cases."—Lecture "On the Relation of Natural Science to General Science."

Of course neither of these attestations is elucidatory, but they suffice to show that in Germany, at least, the axiomatic nature of physical principles is beyond controversy.

Waterbury, Conn., U.S. CHAS. G. ROOT

The Long Peruvian Skull

A KIND correspondent has called my attention to a communication from Dr. Daniel Wilson, of Toronto, in NATURE, vol. x. p. 46, to which my friend considers it incumbent upon me to reply. The communication in question has now reached me, although so late, but I can hardly regard it as requiring any answer, since I am quite satisfied my friend Dr. Wilson in it answers himself. As to his logical arguments, based upon Prof. Wyman's suggestion, that in Dr. Wilson's estimation *the skulls are natural because they are symmetrical*, no one can doubt that Dr. Wilson is fully acquainted with the want of symmetry in a large number of crania of all races. Of this it was scarcely needful for Dr. Wilson to reassure us.

But in reply to the real question at issue, had the ancient Peruvians dolichocephalic or long skulls, as well as brachycephalic, or short skulls? This question I must regard as fully solved, and I look upon it that craniologists consider this race to be brachycephalic. How is it, then, that Dr. Wilson, who has paid great attention to the study of craniology, maintains that there were among the ancient Peruvians two distinct types, a dolichocephalic and a brachycephalic section? A reference to his "Prehistoric Man," the two editions of which lie before me on the table, will suffice to indicate the source of error. I will refer to the figures which are unequivocal. In the first edition of this work, Dr. Wilson gives, Fig. 59, p. 240, vol. ii., the wood-cut of a Peruvian dolichocephalic skull, as an instance of the long skull type natural to the ancient Peruvians. At p. 242 he gives, "Fig. 60. A Peruvian Child's Skull, Normal." This is the woodcut repeated in NATURE, vol. x. p. 48, Fig. 3. Seeing that both these skulls bore unequivocal marks of artificial distortion, years ago I acquainted Dr. Wilson with this fact, when I understood him to reply that the printer had not put the proper figures in the right places. When the second edition of "Prehistoric Man" reached me I looked to see if the right cuts had got put into their proper places, but was surprised to find that at p. 446 the former figure is repeated with the description, "Fig. 58. Peruvian Depressed Skull." This is quite correct, for it is not only depressed, but depressed by art; therefore it cannot be an instance of a natural Peruvian dolichocephalic skull. But at p. 451 the latter woodcut is repeated as "Fig. 60.—Peruvian Child's Skull, Normal," and described as such. Indeed it is not necessary to go beyond Dr. Wilson's communication to NATURE. His Fig. 3, p. 48, is the identical woodcut, as "Peruvian Child's Skull Normal." This woodcut is quite conclusive as to what I have asserted, that Dr. Wilson has answered himself. For it is the calvarium of a child which has been artificially distorted and thereby elongated. And in truth it is only necessary to cast the eye on the figures upon the same page in NATURE to see that all the skulls, Figs. 1, 3, and 4, have all been distorted, and distorted in the same manner, viz. by a figure of 8 bandage, which has left its distinct impressions upon the frontal, parietal, and occipital bones. This distortion has necessarily converted them into dolichocephalic or long skulls, in contradistinction to their natural form, which is exhibited in Fig. 2, on the same page of NATURE. This bandage has been the instrument of distortion, and all three have been deformed in what I call the *cylindroidal* manner, resulting in the lengthening out of the calvarium. It may be observed that this mode of distortion is the most generally diffused of any among human races, both of the old world and the new. The figures differ only in the degree of deformation, the "Fig. 3.—Peruvian Child's Skull, Normal," having been less tightly compressed than the other two. I conclude that it is quite unquestionable that this Peruvian skull cannot be looked upon as a natural Peruvian skull, cannot be adduced as evidence that there was a second type of cranium among the ancient Peruvians. The best inspection I am able to give the figures proves this unequivocally, and I am bound to affirm, with the utmost respect to Dr. Daniel Wilson, that he has fully answered himself, and proved that the asserted long Peruvian skulls are simply crania artificially contorted into dolichocephalic ones. After this it may be very safely said that craniologists, beginning with Morton, and going on to that eminent and accurate anatomist, Prof. J. Wyman, are agreed that the ancient Peruvian race was distinguished by having brachycephalic skulls, as is shown in Dr. Wilson's "Fig. 2.—Peruvian Child's Skull, Santa," NATURE, vol. x. p. 48, which is simply an undistorted and natural example.

Having said this, which is a plain statement of what I believe to be the truth, I may add that I regret to find scientific questions are by some even who have acquired a reputation treated as a source of wrangling (I do not at all allude to Dr. Wilson), which I observe with much regret; but such course I most certainly shall not imitate. If a plain statement of facts does not convince, I shall not try any other method. When Dr. D. Wilson shall produce half a score of ancient Peruvian dolichocephalic skulls, the appearance of which totally precludes the possibility of interference by art or other deforming accident, then the question he introduces will be open for discussion, but, until then, I hold that there is no valid reason to doubt that the ancient Peruvians were a decidedly brachycephalic race.

J. BARNARD DAVIS

IN NATURE, (vol. x. p. 46), Prof. Daniel Wilson replies to criticisms by Dr. J. Barnard Davis and myself, of his conclusion that certain skulls, described and figured in "Prehistoric Man," and belonging to the collections of Dr. Warren, of Boston, had natural and not artificial forms. As far as I am concerned, he quotes from a letter of mine to Dr. Davis the following sentence:—

"The upshot of the whole is the crania do not confirm Dr. Wilson's statement. One of Dr. Wilson's chief points—in fact it is his chief point—is that the skulls are natural because they are symmetrical, and it is next to impossible that a distorted skull should be symmetrical."

In this sentence he says I misrepresent him, and appeals to his published views with regard to asymmetry in skulls in general, about which I had said nothing. I was writing only of those particular ones represented in Figs. 1 and 3 of Prof. Wilson's article in NATURE, and Figs 59 and 60 in "Prehistoric Man." In justification of the paragraph from my letter given above, and to which he objects as unfair, I quote the following sentence from "Prehistoric Man," pp. 449-50:—

"Few who have had extensive opportunities of minutely examining and comparing normal and artificially formed crania will, I think, be prepared to dispute the fact *that the latter are rarely / ever symmetrical*. The application of pressure on the head of the living child can easily be made to change its natural contour, *but it cannot give to its artificial proportions that harmonious repetition of corresponding developments on opposite sides* which may be assumed as the normal condition of the unmodified cranium. But in so extreme a case as the conversion of a brachycephalic head averaging about 6·3 in longitudinal diameter, *the retention of anything like normal symmetrical proportions is impossible*. Yet the dolichocephalic Peruvian crania present no such abnormal irregularities as could give countenance to the theory of their form being an artificial one."

I will only add, that in several distorted dolichocephalic Peruvian crania in the collections of the Peabody Museum at Cambridge, the symmetry is as complete as in any ordinary undistorted crania.

JEFFRIES WYMAN

Cambridge, Mass., U.S.

Lakes with two Outfalls

FIFTY miles south of Denver, Colorado Territory, on the Denver and Rio Grandé R.R., there is a little lake with two outfalls, which I have myself seen. This lake is on an east and west "divide" and is 8,000 ft. above sea-level; the outfall to the north, Plum Creek, goes to the Platte River, while Monument Creek, to the south, flows into the Arkansas.

EDWARD S. HOLDEN

Naval Observatory, Washington, U.S., June 2

CAPT. J. D. COCHRANE, R.N., in his "Narrative of a Pedestrian Journey through Russia and Siberian Tartary, &c., in the years 1820-23," has the following reference. I quote from the American edition (1824), p. 235:—

"In the evening we reached a fertile spot, and halted on the banks of a lake, from which, it is said, the rivers Okota and Koudousou, running in counter directions, have their source, a circumstance which recalled to my recollection those words in an able work by Mr. Barrow upon rivers, wherein it is said that, although it is not a physical impossibility that two rivers should flow in opposite, or indeed in any direction out of the same lake, yet the contrary approaches so near to an axiom in geography that no instance is perhaps known of such an occurrence."

The rivers named flow respectively into the Sea of Okhotsk and the Arctic Sea. Perhaps a reference to other and later works may settle the question whether this lake has two outlets.

Chicago, U.S., June 2 —— S. W. BURNHAM

Palæotherium magnum

THE *Palæotherium magnum*, an account of the discovery of which appeared in NATURE, vol. ix. p. 285, differs in so many respects from that which was restored by Cuvier, that it may be well, if possible, to try and reconcile these two accounts.

Cuvier, in his "Ossemens fossiles" (1825) after taking the individual bones of the *Palæotherium* one by one, and considering their affinities, places them together, and restores from them as far as possible the animals to which they belonged.

In vol. ii. p. 163, he says: "Hence we see in our environs of Paris, and elsewhere, the genus *Palæotherium*, which resembles the tapirs by its incisor and canine teeth, and in that the nasal bones are so arranged as to carry a trunk, whilst the molars more nearly approximate to those of the rhinoceros and deer."

In vol. iii. p. 53, *et seq.* he commences with a description of the skull, and passes on to the other bones in order.

Having considered separately the various bones of the eight species which he describes, he passes on at p. 243 to the restoration of the whole skeleton, considering first that one of which he had the most perfect remains, viz. *Palæotherium minus*, *vide* vol. iii., pl. 34. This skeleton is a more perfect specimen in many ways than that which was discovered the other day, though a good part of the lower extremities are wanting.

Speaking of this specimen Cuvier says (vol. iii., p. 244): "If only we could bring this animal to life as easily as we have put together its bones, we should see running about a tapir smaller than a roebuck, with thin and slender legs." And again, "Its height to the withers would be from 16 to 18 in."

This skeleton, it will be seen, resembles to a great extent that of *Palæotherium magnum*, which was figured in NATURE, vol. ix. p. 286. Having completed the smaller animal, *P. magnum* is next considered, of which Cuvier says: "We have the head and four extremities of this animal; by supplying it with a body like that of its predecessor, it will be very easy to restore its skeleton. Its head and limbs may be seen at pl. 49, 50, and 60, and its restoration at pl. 66, resembling almost exactly that of

P. minus, though the former is much the larger. Such then are the facts as they appear from Cuvier's writings. The fact that this one skeleton of *P. minus* was found with the neck in the erect position may have been considered by Cuvier as hardly a sufficient reason for placing the neck of his restored specimen, which showed so many tapiroid peculiarities, in the same position. Now, however, that a second skeleton of a *Palæotherium* has been found, with the neck in a similar position, the probability that such a position is the natural one is immensely enhanced.

Two points, however, remain somewhat involved in obscurity; first, how is it that the skeleton of *P. magnum*, as found at Vitry-sur-Seine the other day, differs so much in the length of its leg-bones from the *P. magnum* of Cuvier, which it undoubtedly does if the drawings and descriptions of both are correct? and secondly, how was it that Cuvier, with such a perfect skeleton as that in the accompanying figure, should restore an animal with such short and comparatively stout legs?

Someone perhaps may be able to throw some light upon these points.

W. BRUCE-CLARKE

The Telegraph in Storm-warnings

THE idea of using the electric telegraph to give warning of cyclones approaching from a distance is generally supposed to have first occurred to Prof. Henry of the Smithsonian Institution in 1847 (NATURE, vol. iv. p. 390). This however is not the fact, for the same thing had been recommended in India fully five years before by the late Mr. Henry Piddington, in his sixth "Memoir on the Law of Storms," published in the Journal of the Asiatic Society of Bengal in 1842. Referring to a storm which was tracked from Macao to Shih-poo, and its estimated rate of travelling, he says (p. 703):—"If China was a country under European dominion, a telegraph might, when these storms strike the eastern coast, warn those on the southern that they were coming, and in India we might often attain the same advantage. *Our children may see this done.*" In 1849, when he published the first edition of his "Sailor's Horn-Book for the Law of Storms," he had not yet heard of the fulfilment in America of his prophecy, which however he has duly noticed in subsequent editions.

FRED. NORGATE

Corydalis claviculata

A SHORT additional note on *Corydalis claviculata* may be of interest. A sprig placed in a glass of water and out of the way of insects continues to grow and to bear flowers and fruit with nearly as much regularity as if still rooted to its native bank. The flowers do not gape spontaneously; and, as most of the older ones that I have examined in a state of nature have their lips depressed, I think it certain evidence of the agency of insects, though I have not yet been so fortunate as to witness their operations. All the flowers that I have seen are of a greenish white, but dried specimens acquire the yellow tint described in systematic works, a fact which may help to throw light on the somewhat parallel behaviour of *Fumaria pallidiflora*.

Kilderry, co. Donegal — W. E. HART

POLARISATION OF LIGHT*

IX.

THE results of combining two or more colours of the spectrum have been studied by Helmholtz, Clerk Maxwell, Lord Rayleigh, and others. And the combinations have been effected sometimes by causing two spectra at right angles to one another to overlap, and sometimes by bringing images of various parts of a spectrum simultaneously upon the retina. Latterly also W. von Bezold has successfully applied the method of binocular combination to the same problem (*Poggendorff*, Jubelband, p. 585). Some effects, approximating more or less to these, may be produced by chromatic polarisation.

Complementary Colours.—First, as regards complementary colours. If we use a Nicol's prism N as polariser, a plate of quartz Q cut perpendicularly to the axis, and a double-image prism P as analyser, we shall, as is well known, obtain two images whose colours are complementary. If we analyse these images with a prism, we shall find when the quartz is of suitable thickness, that each spectrum contains a dark band indicating the extinction of a certain narrow portion of its length. These bands will simultaneously shift their position when the Nicol N is turned round. Now, since the colours remaining in each spectrum are complementary to those in the other, and the portion of the spectrum extinguished in each is complementary to that which remains, it follows that the portion extinguished in one spectrum is complementary to that extinguished in the other. And in order to determine what portion of the spectrum is complementary to the portion suppressed by a band in any position we please, we have only to turn the Nicol N until the band in one spectrum occupies the position in question, and then to observe the position of the band in the other spectrum. The combinations considered in former experiments are those of simple colours; the present combinations are those of mixed tints, viz. of the parts of the spectrum suppressed in the bands. But the mixture consists of a prevailing colour corresponding to the centre of the band, together with a slight admixture of the spectral colours immediately adjacent to it on each side.

The following results given by Helmholtz, may be approximately verified:—

	Complementary Colours
Red	Green-blue
Orange	Cyanic blue
Yellow	Indigo-blue
Yellow-green	Violet

When in one spectrum the band enters the green, in the other a band will be seen on the outer margin of the red, and a second at the opposite end of the violet; showing that to the green there does not correspond one complementary colour, but a mixture of violet and red, *i.e.* a reddish purple.

Combination of two Colours.—Next as to the combination of two parts of the spectrum, or of the tints which represent those parts. If, in addition to the apparatus described above, we use a second quartz plate Q_1 and a second double-image prism P_1, we shall form four images, say O O, O E, E O, E E. And if A, A′ be the complementary tints extinguished by the first combination Q P alone, and B, B′ those extinguished by the second $Q_1 P_1$ alone, then it will be found that the following pairs of tints are extinguished in the various images.

Image	Tints extinguished
O O	B, A
O E	B′, A′
E O	B′, A
E E	B, A′

It is to be noticed that in the image O E the combination $Q_1 P_1$ has extinguished the tint B′ instead of B, because the vibrations in the image E were perpendicular to those in the image O formed by the combination Q P. A similar remark applies to the image E E.

The total number of tints which can be produced by this double combination Q P, $Q_1 P_1$ is as follows:—

4 single images
6 overlaps of two
4 overlaps of three
1 overlap of four
—
Total, 15

Collateral Combinations.—The tints extinguished in the overlap O O + E O will be B, A, B′ A; but since B and B′ are complementary, their suppression will not affect the resulting tint except as to intensity, and the overlap will be effectively deprived of A alone; in other words, it will be of the same tint as the image O would be if the combination $Q_1 P_1$ were removed. Similarly the overlap O E + E E will be deprived effectually of A′ alone; in other words, it will be of the same tint as E, if $Q_1 P_1$ were removed. If therefore the Nicol N be turned round, these two overlaps will behave in respect of colour exactly as did the images O and E when Q P was alone used. We may, in fact, form a table thus:—

* Continued from vol. ix. p. 508.

Image	Colours extinguished
O O + E O	$B + A + B' + A = B + B' + A = A$
O E + E E	$B' + A' + B + A' = B + B' + A' = A'$

And since the tints B, B′ have disappeared from each of these formulæ, it follows that the second analyser P may be turned round in any direction without altering the tints of the overlaps in question.

In like manner we may form the Table—

O O + E E	$B + A + B + A' = B + A + A' = B$
O E + E O	$B' + A' + B' + A = B' + A + A' = B'$

Hence if the Nicol N be turned round, these overlaps will retain their tints; while if the analyser P_1 be turned, their tints will vary, although always remaining complementary to one another.

There remains the other pair of overlaps, viz.:—

O O + O E	$B + A + B' + A$
E O + E E	$B' + A + B + A'$

Each of these is deprived of the pair of complementaries A, A′, B, B′; and therefore each, as it would seem, ought to appear white of low illumination, *i.e.* grey. This effect is, however, partially masked by the fact that the dark bands are not sharply defined like the Fraunhofer lines, but have a core of minimum or zero illumination, and are shaded off gradually on either side until a short distance from the core the colours appear in their full intensity. Suppose, for instance, that B′ and A′ were bright tints, the tints resulting from their suppression would be bright. On the other hand, the complementary tints A and B would be generally dim, and the image B + A bright, and the overlap B + A + B′ + A′ would have as its predominating tint that of B + A. And similarly in other cases.

There are two cases worth remarking in detail, viz. first, that in which

$$B = A',\ B' = A$$

i.e. when the same tints are extinguished by the combination Q P and by Q_1 P_1. This may be verified by either using two similar quartz plates Q, Q_1; or by so turning the prism P_1 that the combination Q_1 P_1 used alone shall give the same complementary tints as Q P when used alone. In this case the images have for their formulæ the following:—

O O	O E	E O	E E
$A + A'$	$A + A'$	$2A$	$2A'$

in other words, O O and E O will show similar tints, and E O, E E complementary. A similar result will ensue if $B = A$, $B' = A'$

Again, even when neither of the foregoing conditions are fulfilled, we may still, owing to the breadth of the interference bands, have such an effect produced that sensibly to the eye

$$B + A = B' + A'$$

and in that case

$$B' + A = B + A - A + A$$
$$= B + A' + 2A - 2A'$$

which imply that the images O O and O E may have the same tint; but that E O and E E need not on that account be complementary. They will differ in tint in this, that E E, having lost the same tints as E O, will have lost also the tint A, and will have received besides the addition of two measures of the tint A′

Effect of Combination of two Colours. A similar train of reasoning might be applied to the triple overlaps. But the main interest of these parts of the figure consists in this, that each of the triple overlaps is complementary to the fourth single image; since the recombination of all four must reproduce white light. Hence the tint of each triple overlap is the same to the eye as the mixture of the two tints suppressed in the remaining image. And since by suitably turning the Nicol N or the prism P_1, or both, we can give any required position to the two bands of extinction, we have the means of exhibiting to the eye the results of the mixture of tints due to any two bands at pleasure.

Effect of Combinations of three Colours.—A further step may be made in the combination of colours by using a third quartz Q_2 and a third double-image prism P_2, which will give rise to eight images. And if C C′ be the complementaries extinguished by the combination Q_2 P_2, the formulæ for the eight images may be thus written:—

O O O	$C + B + A$
O O E	$C + B' + A'$
O E O	$C' + B' + A$
O E E	$C' + B + A'$
E O O	$C' + B + A$
E O E	$C' + B' + A'$
E E O	$C + B' + A$
E E E	$C + B + A'$

The total number of combinations of tint given by the compartments of the complete figure will be

$\frac{8}{1}$	= 8 single images		
$\frac{8\ 7}{1\ 2}$	= 28 overlaps of two		
$\frac{8\ 7\ 6}{1\ 2\ 3}$	= 56	„	three
$\frac{8\ 7\ 6\ 5}{1\ 2\ 3\ 4}$	= 70	„	four
$\frac{8\ 7\ 6}{1\ 2\ 3}$	= 56	„	five
$\frac{8\ 7}{1\ 2}$	= 28	„	six
$\frac{8}{1}$	= 8	„	seven
1	= 1	„	eight
Total	255		

The most interesting features of the figure consists in this, that the subjoined pairs are complementary to one another, viz.:—

O O O $C + B + A$	E O E $C' + B' + A'$
E O O $C' + B + A$	O O E $C + B' + A'$
E E O $C + B' + A$	O E E $C' + B + A'$
E E E $C + B + A$	O E O $C' + B' + A$

And if the prisms P, P_1, P_2 are so arranged that the separations due to them respectively are directed parallel to the sides of an equilateral triangle, the images will be disposed thus:—

	O E O	O O O	
E E O	E O O	O E E	O O E
	E E E	E O E	

The complementary pairs can then be read off, two horizontally and two vertically, by taking alternate pairs, one in each of the two vertical, and two in the one horizontal row. And each image will then represent the mixture of the three tints suppressed in the complementary image.

Low-tint Colours.—A slight modification of the arrangement above described furnishes an illustration of the conclusions stated by Helmholtz, viz. that the low-tint colours (couleurs degradées), such as russet, brown, olive-green, peacock-blue, &c., are the result of relatively low illumination. He mentioned that he obtained these effects by diminishing the intensity of the light in the colours to be examined, and by at the same time maintaining a brilliantly illuminated patch in an adjoining part of the field of view. If therefore we use the combination N, Q, P, P_1 (*i.e.* if we remove the second quartz plate), we can, by turning the prism round, diminish to any required extent the intensity of the light in one pair of the complementary images, and at the same time increase that in the other pair. This is equivalent to the conditions of Helmholtz's experiments; and the tints in question will be found to be produced.

W. SPOTTISWOODE

VENUS'S FLY-TRAP (*Dionæa muscipula*) *

II.

Contractility of Dionæa.—I have given you a general view of our plant and of its behaviour. We next proceed to examine more particularly that property of contracting when irritated to which the plant owes its faculty of catching insects, and to which my own investigations have been directed. Before beginning the experimental demonstration of the facts, I wish to lay before you some considerations relating to the nature of this property as it manifests itself in living beings belonging to both kingdoms.

We have to do here not merely with contractility but with irrito-contractility. The fact that the property requires two words to express it implies that there are two things to express, viz. (1) that contraction takes place, and (2) that it takes place in answer to irritation. As this is the case not only here, but in all other instances of animal or vegetable active motion, we recognise in physiology these two properties as fundamental: irritability, or *excitability*, and *contractility*, the former designating the property possessed by every living structure whatsoever of being excited to action (*i.e.* of having its stored-up force discharged) by some motion or disturbance from outside; the latter, that kind of discharge or action which results in change of form, and usually declares itself in the doing of mechanical work. This property of excitability, which, let me repeat, is common to all living structures, is, as we have seen, comparable in its simplest manifestations to that possessed by many chemical compounds (of explosiveness) and many mechanical contrivances (of going off or discharging when meddled with, as in the case of the rat-trap already referred to).

In physiology, as in the other sciences of observation, the process of investigation is, throughout, one of comparison. Not only do we proceed from first to last from the known towards the unknown, but what we speak of as our knowledge or understanding of any new fact consists simply in our being able to bring it into relation with other facts previously well ascertained and familiar, just as the geographer determines the position of a new locality by ascertaining its topographical relation to others already on the chart.

The comparison we have to make this evening is between the contractility displayed by the leaf of Dionæa and the contractility of muscle. I choose muscle as the standard of comparison, not merely because it is best known and has been investigated by the best physicists of our time, but because its properties are easily illustrated and understood. I shall be able to show that the resemblance between the contraction of muscle and that of the leaf is so wonderfully complete that the further we pursue the inquiry the more striking does it appear. Whether we bring the microscope to bear on the structural changes which accompany contraction, or employ the still more delicate instruments of research which you have before you this evening, in order to determine and measure the electrical changes which take place in connection with it, we find that the two processes correspond in every essential particular so closely, that we can have no doubt of their identity.

Muscle, like every other living tissue, is the seat, so long as it lives, of chemical changes, which, if the tissue is mature, consist entirely in the disintegration of chemical compounds and the dissipation of the force stored up in these compounds, in the form of heat or some other kind of motion. This happens when the muscle is at rest, but much more actively when it is contracting, in which condition it not only produces more heat than it produces at other times, but also may do—and, under ordinary circumstances, does—mechanical work; these effects of contraction of muscle are, of course, dependent in quantity on the chemical disintegration which goes on in its interior.

Again, muscle so long as it is in the living state is electromotive. This property it probably possesses in common with other living tissues, for it is very likely that every vital act is connected with electrical change in the living part. But in muscle, as well as other irritable and contractile tissues in animals, the manifestation of electromotive force is inseparably connected with the special function of the tissue, *i.e.* with contraction, the connection being of such a nature that the electromotive force expresses, not the work actually done at any given moment, but the capacity for work. Thus, so long as the muscle lives, its electromotive force is found to be on the whole proportional to its vigour. As it gradually loses its vitality, its power of contracting and its electromotive force disappear *pari passu*. When it contracts, the manifestation of electromotive force diminishes in proportion to the degree of contraction. But it is to be borne in mind that, although when the muscle or the leaf contracts electromotive force disappears and work is done, there is no reason for supposing that there is any conversion of the one effect into the other, or that the source of the force exercised by the organ in contracting is electrical.

The lecturer then proceeded to demonstrate the correspondence between the electrical phenomena which accompany muscular contraction, and those which are associated with the closing of the Dionæa leaf, by a series of experiments.*

1. The form of the gastrocnemius muscle of the frog, in the uncontracted state, was projected on the screen with the aid of the electric light. A contraction was then determined by passing through it a single opening induction shock. It was seen to shorten and to become proportionately broader.

[In contraction, the bulk of a muscle remains unaltered. Further, the change of shape of the whole muscle depends on an exactly similar change of shape of every particle of which it is composed. This might be inferred from the consideration that a muscle is not an apparatus made up of parts differing from each other in structure, but a mass of substance equally instinct with life in every part. We know it to be the case by direct observation, for if we observe living muscle in the act of contraction under the microscope (as can easily be done in the muscles of insects), † we see that each minutest fibre participates in the change of form. The same holds good as regards the plant. The agent in the contraction is, without doubt, the protoplasm of the cells of the contractile organs. In Dionæa this has not as yet been sufficiently investigated, but in Drosera Mr. Darwin has shown that when the hairs which project from the upper surface of the leaf, become "incurved" under the exciting influence of appropriate stimuli, the contents of the cells undergo a most peculiar

* Continued from p. 107.

* The statements contained in the first part of this lecture, especially those relating to the mechanism of the closure of the Dionæa leaf and its digestion, are founded almost entirely on information which I owe to Mr. Darwin. The experiments which led to the discovery of the "leaf current" and its "negative variation" were made last autumn, Mr. Darwin having kindly furnished me with plants for the purpose.—J. B. S.

† See Schäfer "On the Contraction of the Muscles of the Water-beetle," Phil. Trans. vol. clxiii. p. 429.

change of form and arrangement, which Mr. Darwin has described as "aggregation."]

2. The image reflected by the mirror of a Thomson's galvanometer having been thrown on the screen near its right edge, it was first shown that when a fraction of a voltaic current passed through the electrodes in a direction from the lecturer's right hand towards his left, the spot on the screen moved towards the left of his audience, The galvanometer having been shut off, a muscle was placed on the electrodes with its cut surface against the left (e') electrode, and its natural surface against the right (e). On again connecting the electrodes with the galvanometer the spot flew off in the same direction as before.

3. The nerve of the muscle having been placed across two wires in connection with the ends of the secondary coil of a Du Bois' induction apparatus, was excited by induced currents, the muscle remaining on the electrodes. The spot returned towards its original position.

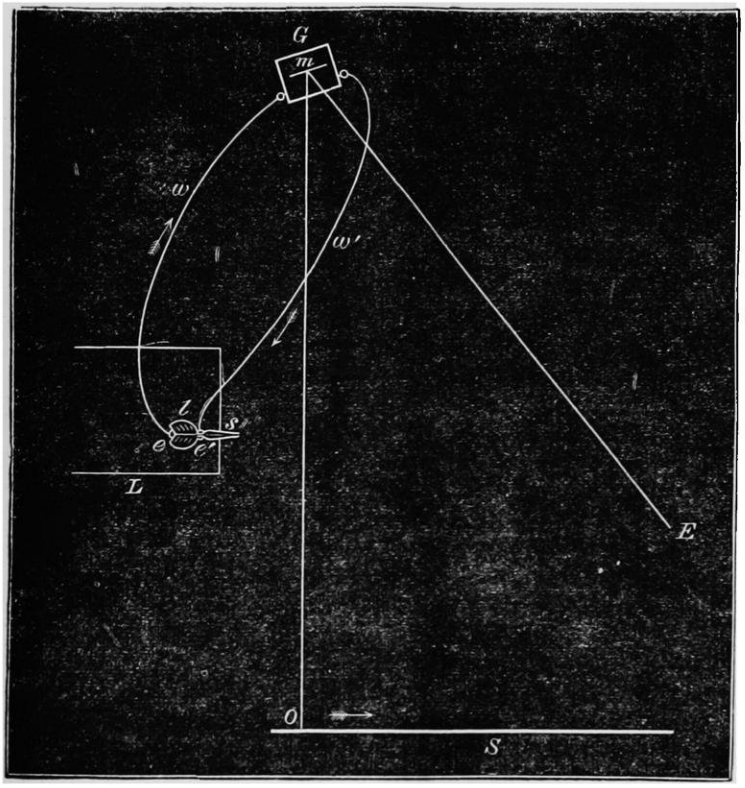

FIG. 1.—Diagram of the experiments.—S, screen facing the audience; E, position of electric light; G, reflecting galvanometer; *m* indicates the direction of the needle and of the mirror fixed to it; O, position of the bright image on the screen when no current exists in the galvanometer; L, end of the lecturer's table to his right; *e e'* his electrodes, on which the blade of the leaf *l* rests, with its stalk *s* towards the lecturer's right; *w w'*, wires leading to the galvanometer. The arrows show the direction in which the current flows through the galvanometer when the leaf is in the position shown. The arrow near O indicates the direction in which the spot of light moves under the influence of such a current.

[In both of these experiments only one-tenth of the muscle-current was allowed to pass through the galvanometer. The electrodes used, which are constructed on the same principle as those of Du Bois-Reymond, are shown in Fig. 2. The glass U-tubes A A′ are half filled with saturated solution of sulphate of zinc. The zinc rods B B′ are in metallic connection with the galvanometer ends by the wires W W′. The ends by which they dip into the solution are carefully amalgamated. The straight tubes C C′ are of such width that they slip easily into the mouths of the U-tubes: they are prevented from going too far by rims of sealing-wax. These tubes are filled with a paste made by rubbing up modelling-clay with one per cent. solution of common salt. The electrodes are so supported that their distance and relative position can be varied with great facility.]

4. The heart of a frog was then placed with its apex against the left electrode (e') and its base on the right (e). The spot moved in the same direction as before, but each heart-beat was marked by a sudden return of the needle towards its original position, indicating the instantaneous disappearance of electromotive force in the act of contraction. The effect corresponding to the contraction of the auricles could even be distinguished from that of the ventricular contraction which succeeded it.

5. A leaf of Dionæa, with its leaf-stalk still attached, was placed with its stalk end on the left electrode and its point on the right, as in Fig. 1. The direction of movement was the same.

6. The spot having assumed a fixed position on the screen, the leaf was excited by touching the sensitive hairs with a camel-hair pencil. The spot flew back towards the right edge of the screen, immediately afterwards returning to its original position. This effect was repeated several times.

7. The leaf-stalk was cut off, the leaf remaining as before on the electrodes. The deflection was increased

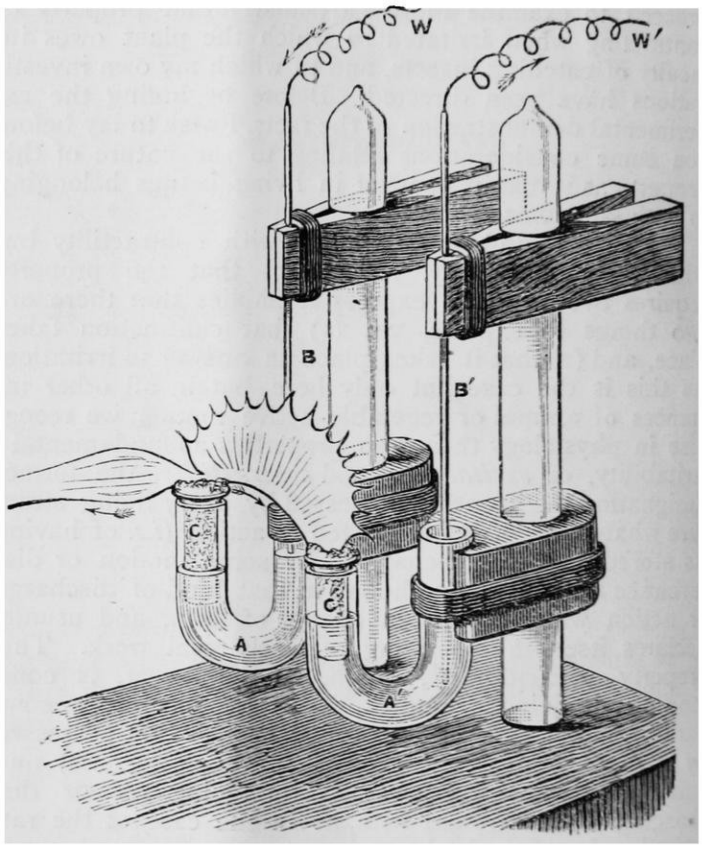

FIG. 2.—Non-polarisable electrodes employed in experiments on the Dionæa leaf.

(more than doubled). It was then explained that when the leaf-stalk is itself placed on the electrodes, the galvanometer indicates the existence of a current opposed in direction to that of the leaf, showing that the electrical conditions on opposite sides of the joint between stalk and leaf are antagonistic to each other. Consequently, so long as leaf and stalk are united, each prevents or diminishes the manifestation of electromotive force by the other. This is completely in accordance with what is observed with reference to nerve, and is known as "electrotonic variation of the nerve current."

8. Two fine pointed electrodes, each in connection with one end of the secondary coil of the induction apparatus, were thrust into the centre of the external surface of a leaf, the ends of which rested on the electrodes of the galvanometer. On thus exciting the leaf the spot of light shot to the left, but it was observed that there was an obvious interval of time between the excitation and the effect. This period, though of much greater duration, corresponds to the so-called "period of latent stimulation" in muscle.

The plants exhibited and used for the experiments were provided by the kindness of the Director of the Royal Gardens, Kew.

FERTILISATION OF FLOWERS BY INSECTS*

VI.

Different Modes of Self-fertilisation where Visits of Insects are wanting

THE two functions of cross-fertilisation and self-fertilisation, which in the previous articles we have seen to occur in different forms of the same species or genus, are in most cases successively presented by the same form of flower; and the modifications by which self-fertilisation is attained by different plants, where visits of insects are wanting, are almost as various as the

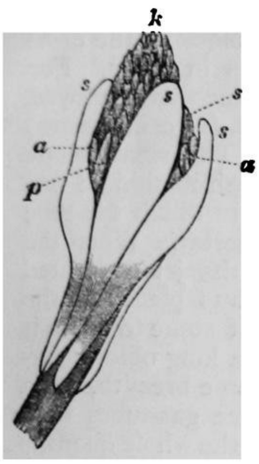

FIG. 32.

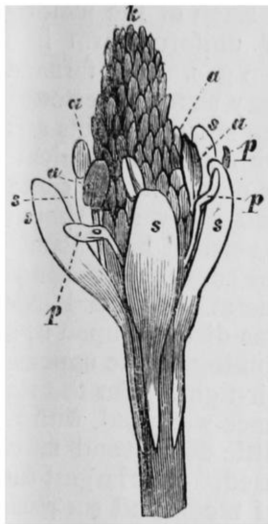

FIG. 33.

FIG. 32.—Side view of flower of *Myosurus minimus* before opening. FIG. 33.—Side view of a flower just open.

contrivances by which cross-fertilisation by insects is secured. Of these various modes I shall here speak only of some not yet referred to in my book on fertilisation.†

Myosurus minimus is as remarkable for the great variability in the size of its flower (compare Figs. 35 and 38) and in the number of its parts,‡ as for the enormous growth of the cone of pistils, which affords no other benefit to the plant but the self-fertilisation of the greater

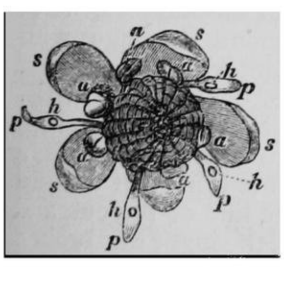

FIG. 34.

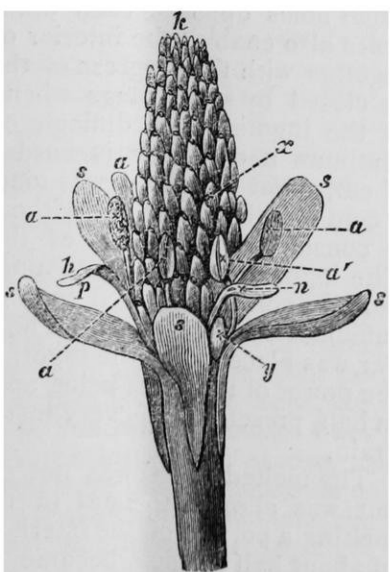

FIG. 35.

FIG. 34.—The same flower viewed from above. FIG. 35.—Side view of a somewhat older flower.

part of the numerous stigmas by the small number of anthers, in case it is not visited by insects.

* Continued from vol. ix. p. 166.

† "Die Befruchtung der Blumen durch Insecten," Leipsig, 1873.

‡ I examined a hundred flowers as to the number of sepals, petals, and anthers, and found the number of sepals in 3 flowers = 4, in 94 flowers = 5, in 3 flowers = 6; petals in 2 flowers = 2, in 20 flowers = 3, in 3 flowers = 4, in 35 flowers = 5; anthers in 2 flowers = 3, in 2 flowers = 4, in 11 flowers = 5, in 22 flowers = 6, in 31 flowers = 7, in 46 flowers = 8, in 5 flowers = 9, in 1 flower = 11.

When the flower opens, it stretches forth its small petals (*p*), which serve as nectaries (*n*), and offer a small drop of honey (*h*), by which very minute insects are attracted in sunny weather. These visitors are for the most part Diptera not exceeding 1-1½ mm. in length, belonging to the genera Sciara, Chironomus,* Hydrellia,* Scatopse,† Phora, Cecidomyia, Oscinis, and Microphorus. I observed also a single specimen of *Melanostoma mellina* (Syrphidæ), some Anthomyia (Muscidæ), a small Haltica, some Pteromalidæ, and small Ichneumonidæ. These minute visitors licking up the drops of honey, and

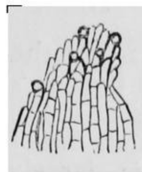

FIG. 36.

FIG. 37.

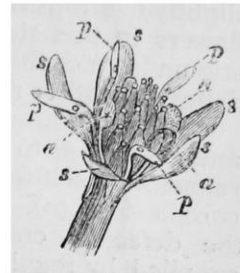

FIG. 38.

FIG. 36.—Stigma of the ovary *x*, Fig. 35, provided with pollen-grains from the anther *a'*, which have already emitted their pollen-tubes. FIG. 37.—Stigma of the ovary *y*, Fig. 35, more developed than the stigma, Fig. 36, provided with two pollen-grains fallen down from the anther *a'*. FIG. 38.—One of the smallest flowers: *s*, sepal, *p*, petal, *n*, nectary, *h*, honey, *k*, cone of ovaries. FIGS. 32–35 and 38, seven times natural size.

walking round the cones of ovaries, stop many seconds in a single flower before visiting another. The anthers, lying close round the cone of ovaries, open by two lateral slits, and are soon afterwards covered with pollen on their whole outside; consequently, insects walking round the ovaries may easily be charged with pollen, and flying to another flower effect cross-fertilisation. But, upon the whole, the flowers, because of their being scentless and very inconspicuous, are so scantily visited by insects, that, after repeated careful examinations, I believe that even in sunny weather more than 90 per cent. of the flowers remain without any visit. This deficiency of secured cross-fertilisation is supplied by regular self-fertilisation in the following manner. The axis of the flower, extending gradually during the blooming-time into

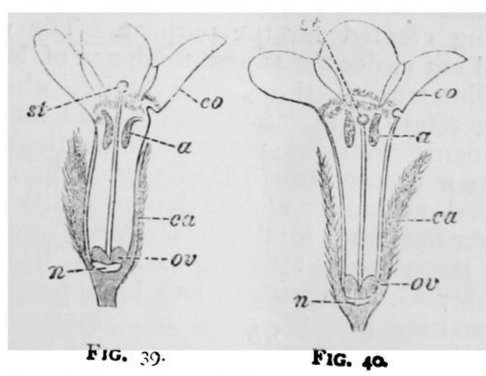

FIG. 39. FIG. 40.

FIG. 39.—Flower of *Myosotis versicolor* when just opened, dissected longitudinally. FIG. 40.—An older flower, with full-grown corolla (seven times natural size): *ca* calyx, *co* corolla, *a* anthers, *st* stigma, *n* nectary, *ov* ovary.

a long cone, brings a great part of the stigmas into contact with the lateral pollen-grains of the anthers; those ovaries which now are in contact with the anthers soon afterwards overgrowing them, and others now below the anthers reaching them.‡ Thus a number of styles grazing the anthers during the growth of the long cone are self-fertilised by about five or more pollen-grains (Fig. 36); besides, also, the lowest stigmas of the flowe are fertilised by their own pollen, many pollen-grains falling down from the anthers (Fig. 35 *y*, Fig. 37). Consequently, only those ovaries are never self-fertilised which

* For instance, *Chironomus byssinus* Schrk., *Hydrellia chrysostoma* Meig., and *griseola* Fall., after Prof. Mik's (of Vienna) examination.

† *Scatopse brevicornis* Löw.

‡ This is easy to be seen by marking some of the ovaries with a spot of ink.

are already situated above the anthers before the opening of the flower.

Whilst in *Myosurus minimus* self-fertilisation is effected by a number of stigmas passing along each of the anthers, *Myosotis versicolor* attains the same effect in the contrary way, all five anthers of the flower passing along the single stigma.

The corolla, when opening, is not only still of a pale yellowish colour, like the buds of other species of Myosotis, but even when not yet fully developed the anthers and pistils are mature at the same time and the stigma slightly overtops the corolla. Hence when insects visit the flowers in this state, their probosces always touch the stigma sooner than the anthers, and consequently, when flying to another flower, always cross-fertilise it.

But by the gradual lengthening of the corolla-tube the anthers affixed to its inner side are raised till they surround and self-fertilise the stigma now enclosed in the corolla (Fig. 40). Thus also in this inconspicuous flower the defective cross-fertilisation by insects * is largely supplied by regular self-fertilisation.

HERMANN MÜLLER

INTERNATIONAL METRIC COMMISSION AT PARIS

Melting of the Metal for the new Metric Standards

AT the meeting of the Executive Committee of the International Metric Commission in October last, the fusion of the large single ingot of platinum-iridium, weighing 250 kilogrammes, out of which all the new metric standards were to be constructed, was fixed for the end of the following April, but the completion of the operation was delayed by accidental circumstances until the middle of the following month. As this was the first occasion on which any attempt had ever been made to melt together more than a few kilogrammes of platinum or of platinum alloyed with iridium, it was necessary to make a great number of experimental meltings during the intermediate time in order to secure success in the great operation.

All the actual meltings of the platinum and iridium have been made at the Conservatoire des Arts et Métiers, in a building erected for the purpose. The work has been carried out under the superintendence of M. Tresca, the Sous-Directeur of the Conservatoire, who is also honorary secretary of the Commission, and more immediately intrusted with the technical operations of constructing the new standards. He has had the advantage of the cordial assistance of Mr. George Matthey, of the firm of Johnson and Matthey, Hatton Garden, from whom the large mass of platinum and iridium was obtained. Mr. G. Matthey has had large personal experience in melting platinum, and he remained at Paris from the beginning of April assisting in the work.

It was necessary that the whole of the platinum and iridium should be separately assayed and purified previously to their being melted together. This process was entrusted to M. Henri Sainte-Claire Deville, and carried out at the Ecole Normale, of which he is director. The greatest difficulty in the purification consisted in getting rid of the osmium, which is found in the natural ore in combination with platinum and with iridium. But the chemical difficulty was satisfactorily overcome by M. Deville after many experiments made by him.

The whole of the platinum and iridium had thus been ascertained to be perfectly pure when delivered to M. Tresca for melting. The first process was to melt portions of the pure platinum, its melting point being about 1,900° C., and considerably lower than that of iridium, which is about 2,400° C. Portions of the platinum were then remelted together with iridium, in the proportions fixed upon of 90 per cent. of platinum and 10 per cent. of iridium. Quantities of from 10 to 15 kilogrammes of platinum-iridium were, in the first instance, melted together. Several of these smaller ingots were then remelted into larger ingots of rather more than 80 kilogrammes each, and the final operation was to remelt three of these larger ingots into a single ingot of 250 kilogrammes.

Each of the meltings was made as nearly as possible of uniform form in a furnace heated with oxy-hydrogen gas. The furnace was made of a block of the ordinary sandy limestone used for buildings in Paris. For the smaller ingots a square block of stone was employed with a hemispherical cavity about 6 in. (15 centimetres) in diameter, for containing the metal. This small block had a cover of similar form, and through its middle was a vertical hole, about ¾ in. in diameter, in which the tube for conveying the gas was fixed with mortar. When the metal was placed in the furnace, and the jet of lighted gas directed upon it, sufficient mortar was placed on the joining of the upper and lower blocks of stone to make it air-tight. For the three larger ingots a long oblong furnace was used, with a cavity of the same breadth, but a little deeper and much longer, and three gas-tubes were used. The largest furnace required for the whole quantity of metal had six gas-tubes, each about 1 in. in diameter, inserted in the upper block. The ordinary illuminating gas was used, mixed with the requisite proportion of oxygen gas, made on the premises and stored in a large gasometer placed near the furnace-room. For obtaining a sufficient blast the power of a 15-horse steam-engine was employed.

In order to facilitate the melting, it was necessary first to divide the larger ingots into small pieces. About half the quantity for a single melting, thus divided into small lumps, was placed in the mould, and when this was completely melted the remainder, which had been drawn out into long thin bars, was introduced gradually through two small holes opposite each other in the furnace. These holes also enabled the interior of the furnace to be seen, together with the progress of the melting, and they could be closed by stone plugs when requisite. The division of the ingots was a difficult operation, as this alloy of platinum and iridium is harder than ordinary steel. A V cut, about ½ in. deep, was made around the ingot with a cold chisel, though not without splintering the edges of a considerable number of the best-tempered chisels. The ingot was then placed under a hydraulic press, supported upon the rounded tops of two strong iron bars, a sufficient distance apart. The rounded part of a third bar was placed upon the ingot, in the line of the cut, and the power of the press being applied, the ingot was broken in half, presenting in every instance a regular crystallised grain.

The melted metal was not cast into a separate mould, but was allowed to cool in the furnace. During the melting a portion of the interior of the stone, to the depth of about half an inch, became coloured by the excessive heat and formed into lime in a powdery state, which floated on the surface of the melted metal. When the metal was sufficiently cool, the stone mould was broken and the ingot removed to a bath of hydrochloric acid, which dissolved every portion of lime or other foreign matter upon the surface of the ingot, but does not act upon platinum-iridium. The ingot was then left quite clean and pure.

The first of the larger ingots of 80 kilogrammes was successfully melted on April 25. The second was melted on May 1, when Marshal MacMahon, the President of the

* After having repeatedly watched in vain the flowers of *Myosotis versicolor*, I succeeded twice in seeing it fertilised by insects, viz.: May 15, 1873, I observed *Bombus agrorum* F. ♀ and June 2, 1873, *Halictus sexnotatus* K. ♀, *H.* [illegible] Sm. ♀, *Rhingia rostrata* L., and *Syritta pipiens* L., all of them successively sucking flowers of different stems. But certainly by far the greatest part of all the flower remains without any visit of insects.

Republic, accompanied by M. Deseilligny, the Minister of Commerce, were present unofficially, and remained during the whole process, appearing to take great interest in the operations. The third of the larger ingots was melted on May 7.

The melting of the great ingot of 250 kilogrammes took place on May 13, in presence of nearly every member of the French Section of the Commission, of M. Struve from St. Petersburg, MM. Stas and Heusschen from Brussels, M. Bosscha from Holland, Prof. Miller and Mr. Chisholm, delegates from Great Britain, and other foreign commissioners. It was successfully accomplished with the greatest facility and regularity, and without the slightest hitch or accident.

The dimensions of the cavity in the furnace, and consequently of the large ingots produced, were as follows :—

	Mètre		Inch
Length	1·24,	or about	44·9
Breadth	0·15,	„	5·9
Depth	0·07,	„	2·8
Thickness of stone above the cavity	0·15	„	5·9

The time occupied in the process was as follows :—

2.10 P.M.—Furnace heated and lighted by degrees.
2.24 „ —Furnace thoroughly heated.
3.4 „ —Contents of metal (130 kilogrammes) melted and bars begun to be introduced.
3.27 „ —All the metal melted.
4.15 „ —Metal entirely solid, but still at white heat ; lid lifted.

In about half an hour the mould was broken and the ingot removed to the hydrochloric bath. When taken out it was examined, and found, to all appearance, perfect.

The stone used is so remarkably slow a conductor of heat, that when the whole mass of metal was in a melted state the upper surface of the stone was hardly warm, as was tested by the hands of several of the persons present being placed upon it.

Portions of the three large ingots had been previously tested and found to be very nearly indeed of pure platinum and pure iridium in the proportions of 9 to 1. The large ingot will also be assayed, and, if deemed necessary, again melted, in order that the requisite homogeneity may be attained.

The work of constructing all the new line-standard metres from this single ingot will at once be proceeded with, and there will be sufficient surplus metal for making first all the new standard kilogrammes, and then such number of end-standard metres as may be required.

H. W. CHISHOLM

SOUNDINGS IN THE PACIFIC

THE voyages of the U.S. steamer *Tuscarora*, Capt. Belknap, engaged in soundings for a cable from America to Japan, have been already described between Cape Flattery and Oonalaska Island (vol. ix. p. 150), and between California and the Sandwich Islands. They have now been extended from the last-named station to the coast of Japan. Sixty casts were taken at intervals of about 50 miles. In the first 95 miles from Honolulu, the depth increased at nearly 162 ft. to a mile, reaching 2,418 fathoms in lat. 21° N., long. 159° 20′ W. The average depth of all the casts taken during this voyage was 2,450 fathoms. Between the mountains (all but one of which are entirely submarine) the bed of the ocean was very level; the greatest depth was found at lat. 22° 44′ N., long. 168° 23′ E., 3,262 fathoms. These mountains were as follows :—(1) Summit about lat. 20° 41′ N., long. 171° 33′ W. ; height 5,160 ft. ; eastern slope 40 ft. and western 128 ft. to the mile. (2) Summit, lat. 21° 41′ N., long. 176° 54′ E. ; height 12,000 ft. ; eastern slope 37 ft. for about 127 miles and 51 ft. thence to summit ; western slope 55 ft. (3) Summit 23° 45′ N., long. 160° 56′ E. ; height 9,600 ft. ; eastern slope 192 ft. ; western 204 ft. (4) Summit, lat. 23° 55′ N., long. 158° 7′ E. ; height 6,000 ft. ; eastern slope 60 ft. ; western, inappreciable for 45 miles from summit, afterwards 90 ft. per mile to its base. (5) Summit above water, known as Marcus Island, lat. 24° 12′ N., long. 153° 57′ E. Soundings 7 miles to northward, lat. 24° 20′ N., long. 154° 6′ E., gave 1,500 fathoms depth ; northern slope to this point 1,284 ft. to the mile ; eastern slope thence, 200 ft. ; western 157 ft. (6) Summit, lat. 25° 42′ N., long. 148° 39′ E. ; height 7,800 ft. ; eastern slope 163 ft. ; western 59 ft. From the base of the last mountain to Port Lloyd, Peele Island, the upward slope was 86 ft. to the mile. All the slopes are estimated at a minimum.

All specimens brought up from summits of mountains or ridges were white coral or pieces of lava, and indicated otherwise a hard and rocky bottom : all from the level bed were of soft brownish-yellow mud. It will be noticed that the position of Marcus Island has been hitherto incorrectly indicated on the charts—too much to the north and west. It is about 4 miles in length from east to west and is thickly wooded and frequented by large flocks of birds. Another island laid down on the charts as somewhat to the southward of Marcus Island has no existence, and the facts are similar in regard to several reported shoals and rocks indicated on the charts ; the *Tuscarora* sailed over their alleged positions, and found from 1,500 to 3,000 fathoms of water.

Bottom temperatures, as in other parts of the Pacific, range from 33°·2 F. to 34°·6 below 1,800 fathoms, whatever the additional depth. Between 1,200 and 1,800 fathoms the temperature rises slowly to about 35° at the former depth. From 1,200 fathoms to the surface the thermometer rose steadily ; surface temperatures ranging from 70° to 76° F.

Observations on currents are made from a boat when the sea is moderately smooth. For investigating deep currents the sinker of the apparatus is of about 10 lbs. weight ; it consists of four rectangular pieces of doubled tin soldered at right angles to each other, each 6 in. square, and with the requisite quantity of lead attached in strips through holes punched in the lower edges of the sheets. A small silk fishing-line supports the sinker, running through the float, which is a wooden cube 5 in. square at the surface by 4 in. in depth ; the line runs to a reel in the boat, having a toggle placed on it just above the float. For observing surface currents a similar sinker is constructed of wood weighted to sink about 2 fathoms. The line attached to it is marked in tenths of knots by small corks, which also prevent errors that would otherwise accrue by the line sinking.

A fixed point of departure is obtained by lowering the sounding apparatus and bringing the sounding wire in a vertical position after bottom is reached. From this point the current-measuring apparatus is thrown overboard, and its rate and direction of progress measured at frequent intervals of time. The small errors due to friction are easily eliminated, and the elements of calculation are exceedingly simple. An approximate method of obtaining the surface current when dredging is by anchoring the boat to the dredge lines as a fixed point. In deep currents the float is vertical over the sinker.

The voyage occupied twenty-eight days, and the weather was exceptionally favourable. There are only sixty-five inhabitants on Peele Island, and the *Tuscarora* was the first visit of a naval vessel for more than seventeen years ; Commodore Perry stopped at the island in 1853. A Mr. Savory, formerly a whaler, from Massachusetts, had exercised the functions of governor, consisting principally of presiding over marriages and funerals, for many years, and died last March at the age of eighty, a Mr. Thomas Webb succeeding to the position and honours. In 1827 Capt. Beechy, R.N., took possession of the island in the name of George II., but the Japanese claim it by right of prior discovery and occupation. It is principally frequented by whalers, for supplies. There are no notable features in the sea-bed between this island and the coast of Japan.

COGGIA'S COMET

THE latest observations taken here give the following position of this comet, which, compared with that of June, published in NATURE, vol. x. p. 113, shows the present direction of the motion.

June 14, at 10h. 42m. 30s. mean time at Twickenham.

R.A.	7h. 7m. 24·56s.
D.	$+ 68° 56' 31''·5$

The comet on this evening was distinctly visible to the naked eye, sensibly brighter than 43 Camelopardi, and therefore rather higher than the fifth magnitude. Towards midnight it was possible to detect a difference between its appearance, without the telescope, and that of neighbouring stars.

There appears a decided similarity between the elements of this comet and those of the second comet of 1737 observed by the French Missionaries in China. For the latter body I have calculated the following orbit, from the observations, or rather the estimated places, published by the Baron de Zach (Mon. Corresp. xxi. p. 318).

Perihelion passage 1737, June 2·230 Greenwich M.T

Longitude of perihelion	261° 58′
Ascending node	132 5
Inclination of orbit	61 52
Perihelion distance	0·8348

Motion—Direct.

Daussy's elements of this comet which appear in our catalogues are certainly defective.

The present comet was detected when the true anomaly before perihelion exceeded 100°, and there is every probability that Mr. Stone at the Cape of Good Hope may be able to furnish a good normal place at a large arc of anomaly after perihelion. Hence the period of the comet may be determined directly from the observations. In another week's time we shall doubtless know very nearly the course which it will take when near the earth and sun in the first half of July; but so far, the determination of the elements has been one of no ordinary difficulty, as I find the continental computers have remarked as well as myself.

J. R. HIND

Mr. Bishop's Observatory, Twickenham, June 16

NOTES

WE need not say much on Monday night's debate as to the appointment of a minister of Education; as we have already often referred to the subject our ideas must be known. Mr. Lyon Playfair's appeal was certainly strong, unanswerable we think, but it referred too much to education and too little to science. Our scientific administration ought to be as strong as that of our law, and we are confident that it ultimately will be. Sir John Lubbock's speech was admirable. He said it was surely a great mistake to suppose that the business of an Education Minister would be confined to questions relating to elementary schools. We must, he thought, take a broader view of the question. "We had," he said, "large educational endowments, but a system which was not even now in harmony with the present state of things, and which consequently does not produce the results which might reasonably be expected. If there had been a Minister of Education the Endowed Schools would not have been allowed to fall into the condition in which too many of them were when the Endowed Schools Act was passed." Speaking of the Fellowships of Oxford and Cambridge, numbering 720, he said, "Out of the whole number he believed that not above a dozen had been given for proficiency in Natural Science, while even as regarded the Scholarships those offered for Natural Science are only a small fraction of the whole. But then the Colleges said, and said with some force, that they could not do more for Natural Science because the subject was not sufficiently taught in the schools; while, on the other hand, the schools did not teach it because so few inducements were held out at the Universities. Both admitted that a change was needed, but each was waiting for the other. Here, again, the influence of some co-ordinating authority was much needed. Then there was the management of our museums. It was generally felt that the erection of the new Natural History Museum at South Kensington should be taken advantage of to effect a change in the governing authority of the British Museum; that, as recommended by the Science Commission, the national collections should be under the charge of directors, responsible to a special Minister of State. At present the different national collections were in competition, not in harmony." The arguments urged in favour of the appointment of an Education Minister were simply eluded by its opponents, though it is at least consoling to think that Mr. Disraeli's speech was carefully guarded; indeed the opinion of many is that in time he will see his way to supporting the appointment of such a Minister.

IN reply to a question in the House of Commons on Monday Lord Sandon stated that arrangements had been made for bringing the various departments at the South Kensington Museum more directly under the control of the Education Department at Whitehall.

LORD RAYLEIGH, F.R.S., a member of the Council of the Mathematical Society, is about to do a very handsome thing, which will make that Society greatly indebted to him, and which should earn the gratitude of all mathematicians and therefore of all scientific workers. He has expressed his intention of presenting 1,000*l*. to the Mathematical Society to assist it in the publication of its Proceedings and in the purchase of mathematical periodicals. The application of this handsome gift shows great discrimination on the part of the donor.

THE Professorship of Zoology and Comparative Anatomy at King's College, London, is rendered vacant by the resignation of Mr. T. Rymer Jones, F.R.S., who has held it since the year 1836.

WE regret having to record the death on June 6 of Dr. Hermann Vogelsang, Professor in the Polytechnicum of Delft, at the early age of 36. He was well known for his various publications on subjects connected with the microscopical structure of rocks and minerals.

AT the meeting of the French Academy on June 8, the death was announced of M. Roulin, librarian to the Academy, and editor of the first volumes of the *Comptes Rendus*.

THE deputation of the Royal Geographical Society which waited on Government in reference to the family of the late Dr. Livingstone recommended that 10,000*l*. or 11,000*l*. should be granted; but it seems the Government have thought 3,000*l*. sufficient, with about 1,000*l*. by way of payment of arrears due to the followers and servants of the doctor. This is in addition to the 200*l*. pension, which is to be continued to the family. The Geographical Society seems to be quite satisfied with this arrangement.

IT seems to be generally allowed that this year's Cambridge commencement has been unusually brilliant; the number of honorary degrees conferred on Tuesday was very large. The names of the scientific men to whom the degree of LL.D. was given we have already mentioned. At the same time the thanks of the

University were conveyed to the Chancellor, the Duke of Devonshire, for his handsome gift of the Cavendish Laboratory. At the Oxford Encaenia yesterday, the degree of D.C.L. was conferred, among others, upon Victor Carus, Professor of Comparative Anatomy and Zoology in the University of Leipsig.

WE congratulate the University of Cambridge that its Board of Natural Science Studies have at last come to see that the Oxford system in the Natural Sciences Tripos is the only workable one, and the only one which can lead to really valuable results and the discouragement of cramming and superficiality. The Board having had under consideration the reports of the examiners for the Natural Sciences Tripos for several successive years, which express more or less dissatisfaction with the present system on account of the inducements it offers to the candidates to spread their reading over a wide area rather than to study deeply a limited section of natural sciences, think that the objects of the examination—viz. to offer sufficient stimulus to exertion, and at the same time to give encouragement to sound study—will be best secured by dividing the first class into two divisions, and by arranging the names in each of these divisions and in each of the other two classes in alphabetical order. They think it desirable that the first class should consist of those who, having shown adequate general knowledge in the first three days of the examination, have shown superior proficiency in some one, at least, of the branches of natural science included in the examination, and that in the case of every student placed in the first class, the subject or subjects for knowledge whereof he is placed in the first class be signified in the published list. They are also of opinion that it is desirable that those who pass the first three days' examination with credit should be entitled to admission to the B.A. degree. To carry out these recommendations the Board propose certain alterations in the rules of the Tripos defining more strictly the parts to be included in the first three days' examination, and add regulations to carry out their new scheme.

As the statute for settling the future stipend of the Professsor of Geology at Oxford has now passed Convocation the Vice-Chancellor will proceed to an election in the course of the present month. Any gentlemen who have not already sent in their names are requested to do so on or before Saturday, June 20.

THERE are several points in connection with the Annual Commemoration of the University of Sydney, held on March 28 last, which are worthy of notice, and which must be pleasing to the friends of scientific education. The number of students attending lectures at the University during the past Session was 48, being the largest number at one time since the establishment of the University The number of "superior graduates" now in the University is 87; on this reaching 100 it will be entitled to send a representative to the Legislative Assembly. In recognition of the zeal and efficiency with which Mr. Liversidge has performed his duties as Reader in Geology and Mineralogy, the Senate have promoted him to the higher grade and position of Professor in those sciences, and Demonstrator in Practical Chemistry, and have also voted 500*l.* for the improvement of his laboratories.

Further the Senate of Sydney University have made what many of our readers will regard as a wise law; viz. that candidates, who at the second yearly examination should have displayed a marked proficiency in any one of the three schools of classics, mathematics, or natural science, should be allowed, on the recommendation of the examiners, to devote themselves in their third year exclusively to the subjects of that school, and to be examined for B.A. in them only.

At the same commemoration, a very gratifying act of munificence was announced. Mr. William Macleay, M.L.A., F.L.S., has expressed his intention of bequeathing to the University his valuable library and collection of natural history, upon trust for the promotion of that science, and the instruction of the students and the inhabitants of the colony in the same. He also expresses his intention of leaving to the University the sum of 6,000*l.*, the interest upon which is to be applied to the payment of the salary of a properly-qualified curator, to be specially and exclusively employed in the care and preservation of the specimens belonging to the collection, or any additions that may be made to it. The library already consists of about 2,000 volumes, and Mr. Macleay states that he is continually adding to it all the most valuable of the periodicals and proceedings of Societies of Natural History, published in England, France, Germany, Belgium, and Russia. It includes a large number of books on Natural History, which belonged to the late Mr. William Sharpe Macleay, F.L.S., and which have been presented by his brother, Mr. George Macleay, C.M.G., F.L.S., to accompany the collection. The collection of specimens, we believe, may be considered one of the most extensive and valuable in the world. It was first formed by the late Alexander Macleay, F.R.S., F.L.S., and was considered about fifty years ago the first collection in Europe. Many additions were made to it by his son, the late Mr. W. S. Macleay, who, as well as his father, was considered one of the most eminent entomologists of his day. During the last fifteen years the collection has been greatly enriched by the present owner, Mr. William Macleay, by the accumulation of large numbers of Australian insects, besides a considerable collection from other parts of the world. The library and collection are to be maintained and known by the name of the "Macleayan Natural History Collection," and to be open to the inspection of the students of the University and the general public, at all such proper and convenient times as may be appointed for that purpose. From the admirable spirit which seems to animate the University of Sydney, we should think this munificent gift is likely to be fruitful of the best results.

ON June 10 W. H. Miller, F.R.S., Professor of Mineralogy in the University of Cambridge, was elected a Fellow of St. John's College, Cambridge. Prof. Miller took his degree at the college and was formerly for several years a Fellow. He has now been elected for the second time under the statute empowering the college to elect as Fellow "any person eminent for Science or learning." At the same time the Very Rev. C. Meridale, Dean of Ely, Prof. J. C. Adams, and T. Todhunter were elected Honorary Fellows. C. T. Clough, and J. N. Langley have been elected Scholars for proficiency in Natural Science, and A. M. Marshall (Scholar 1873) has received an exhibition in augmentation of his scholarship. First class in the college examination in Natural Science (alphabetical order):—Clough, Langley, Marshall, and Stewart.

WE are glad to see from the Fourth Annual Report of the Devon and Exeter Albert Memorial Museum, Schools of Science and Art, and Free Library, that all departments of the institution are in a flourishing and satisfactory condition. It is gratifying to see that the Science schools are gaining ground, and we hope the Committee will do all in its power to develop these and induce those for whose benefit they are intended to take advantage of them. The museum has been greatly improved during the past year by the addition of cases, the arrangement of specimens, and the acquisition of a number of skeletons of typical vertebrates.

WE are pleased to see from the Sixteenth Report of the East Kent Natural History Society that it is in a satisfactory condition as regards members, funds, and work; the number of members at the end of 1873 was 97; several valuable and appropriate books have been added to the library and a new microscope purchased. Several important papers have been read bearing on local and general natural history.

THE Committee of the Leeds Mechanics' Institute and Schools of Art and Science have resolved to accede to a generally expressed wish that they should organise a Yorkshire Exhibition of Arts and Manufactures, to be opened in Leeds on May 1, 1875. The object of the Exhibition will be to promote the Fine Arts and Art and Science as applied to Manufactures, and the surplus funds will be applied to the liquidation of the debt now remaining on the Leeds Mechanics' Institute.

A VERY successful meeting, under the presidency of the Mayor of Bristol, was held at the Victoria Rooms, Clifton, for the purpose of inaugurating the formation of a College of Science and Literature for the south and west of England and South Wales, to which we referred in NATURE, vol. x. p. 93. The meeting was perfectly harmonious, and we have no doubt that the scheme so auspiciously begun will be successfully accomplished. It is evidently intended that science will hold an equally important place with literature in the new college.

WINGE AND HEIBERG, of Christiania ("Die puerperalen und pyaemischen processe," H. Heiberg, Leipzig, 1873), point out the remarkable presence of a fungus, which is at least very like a vibrio, in the basis of the sore in cases of pyæmic ulcerative endocarditis (*Mycosis endocardii* Winge), and Heiberg shows in similar cases the crowding of such beings in the superficial lymphatics of some of the viscera. This appears to be an important contribution to the views of Lister as to the septic character of the pyæmic diseases.

A PIECE of native gold weighing 200 kilogrammes, and worth 24,000*l.*, has been found in French Guyana, and sent to Paris to be placed in the Colonial Exhibition at the Champs Elysées.

THE French Academy of Sciences has held a long secret committee meeting on the propriety of granting to M. Chapelas-Coulvier-Gravier a sum of money for his meteoric observatory on the upper part of the Luxembourg Palace. A very strong opposition was offered, and it is doubtful whether the grant will be allowed.

UPWARDS of a year ago there was founded at Berlin in connection with the German Geographical Society, a "German Society for the Exploration of Equatorial Africa," or, shortly, the "African Society," having for its president the well-known Dr. Bastian, and vice-president Dr. Neumayer. The Society has received handsome subscriptions to enable it to carry out its object, including a large sum from the Government. An expedition under Dr. Paul Güssfeldt was soon organised, and in the end of May left Liverpool for the west coast of Africa, in the steamer *Nigritia*, which unfortunately was wrecked off Sierra Leone on June 14, Dr. Güssfeldt losing nearly all the equipments of the expedition. He got another ship to take him to Cabinda in Congo, the seat of the German African Trading Company, where he found Dr. Bastian, who had also gone out to organise the work of the expedition. From Cabinda as a starting-point, several journeys have already been made into the interior, and in the *Correspondenzblatt* of the Society, several numbers of which have been issued, an account of the work done is given in a number of letters from Dr. Bastian, Dr. Güssfeldt, and others.

WE are glad to see that the governors of the Burnley Grammar School in the reconstruction of the buildings have given considerable facilities for the practical teaching of Science. They have provided, among other rooms, two well-contrived laboratories, one of which is to be devoted to chemical manipulation, and the other to experimental physics. The school is expected to open on August 1, and the governors have elected as headmaster Mr. Joseph Hough, B.A. (Cambridge), now Science Master at the Rossall School. It is likewise the intention of the governors to found a central science school, which shall be open in the evening for the instruction of persons occupied in the day-time in commercial pursuits. This school is intended to carry out the recommendation of the Commission on Scientific Instruction in one of their recent reports.

MR. GEORGE SMITH has returned from his second Assyrian expedition. He brings home a very large collection of new cuneiform tablets and fragments, as well as a great many interesting objects of Assyrian art, including the entire lintel in sculptured stone of one of the ancient palace gateways.

THE forthcoming number of Petermann's *Geographische Mittheilungen* will contain an important contribution by Prof. Hanns Höfer, the geologist of Count Wilczek's expedition of 1872, on the geography of Spitzbergen. The paper contains the results of careful observation on the harbours, the configuration of the island, especially in the neighbourhood of Horn Sound, and on the glaciers, which were minutely explored.

A NOVELTY in legislation consists in the recent introduction into the U.S. Congress of a bill proposing to grant the State of Minnesota 200,000 acres of land within its limits, the proceeds of which shall be kept as a perpetual fund, the interest to be applied to the support, maintenance, and equipment of an astronomical observatory and school of mines at St. Anthony's Falls in connection with the Minnesota State University. A special stipulation in this proposed act is that the schools shall be free of charge to all students.

WE have received the first two numbers of the *Quarterly Journal of Conchology*, conducted by Messrs. W. Nelson and J. W. Taylor (Hardwicke). We should think it likely to prove of considerable value to the class to which it is addressed.

WE have received the Report of the Ashmolean Society for the year 1873. During last year the Society has held Seven General Meetings, at which a number of valuable scientific papers were read by well-known men of science.

MESSRS. MACLACHLAN and Stewart, of Edinburgh, have ready for immediate publication a work entitled the "Birds of Shetland," with observations on their habits, migration, and occasional occurrence, by the late Dr. Saxby. It will be published at one guinea.

THE various learned bodies of Massachusetts, especially the American Academy of Arts and Sciences, and the Boston Society of Natural History, are urging upon the Legislature the importance of undertaking a new and thorough scientific survey of the commonwealth. The results expected from such a survey at the present time are a detailed topographical map on a scale of an inch to the mile, maps coloured to show the distribution of rock-formations and economic minerals, with charts on a larger scale of particular localities having special interest or importance; also full descriptions of everything connected with the theoretical and economical mineralogy and geology of the State, and especially full descriptions and truthful illustrations of the animals and plants, including their natural history, transformations, and relations to man and his requirements.

THE additions to the Zoological Society's Gardens during the past week include a Vulturine Guinea Fowl (*Numida vulturina*) from East Africa, presented by Dr. J. Kirk; a Stump-tailed Lizard (*Trachydosaurus rugosus*) from Australia, presented by Mr. N. Clements; a Spotted Cavy (*Cœlogenys paca*) from South America, presented by Mr. J. W. Alexander; a Crested Agouti (*Dasyprocta cristata*) from Colon, presented by Mrs. Wood; a Persian Gazelle (*Gazella subgutturosa*) and a Fennec Fox (*Canis fennec*) from Persia, presented by Mr. E. S. Dawes; two Cormorants (*Phalacrocorax carbo*), British, presented by Capt. Salvin; five Mandarin Ducks (*Aix galericulata*) hatched in the Gardens.

SCIENTIFIC SERIALS

Justus Liebig's Annalen der Chemie und Pharmacie. Band 171, Heft 2 und 3.—These parts contain the following papers:—On aldehyde derivatives of napthylamine, by Dr. G. Papasogli. Napthylamine sulphite gives with benzaldehyde napthylamine-benzoyl bisulphite, $C_{10}H_9N.SH_2O_3.C_7H_6O$. This substance is decomposed on heating into sulphur dioxide, water, and a resinous substance of the formula $C_{17}H_{13}N$.—Action of amides on phenol, by Dr. J. Guareschi. The author has tried the action of benzamide and acetamide, also the action of benzamide on cresol, on methyl salicylate, and on ethyl salicylate.—The same author contributes a paper on the various cymenes. Seventeen of these bodies are described and tabulated with bibliographical references. Franz Meilly contributes a long paper on aconitic acid, to which substance the author assigns the constitutional formula

```
CH
||   \
||    >O
C—CO/
|
CH2CO2H
```

—The following are communications from the laboratory of applied chemistry of Hilger's University:—On Bavarian eclogite by Dr. Gerichten.—On a method of analysing crystalline minerals, by the same.—On a titaniferous iron of abnormal composition, by the same.—On abnormal constituents of urine after taking asparagus, by A. Hilger.—The solubility of tellurium and selenium in sulphuric acid, by the same.—On the quantitative determination of iodine in urine, by the same.—"Synthesis of Phenylbutylene" is the itle of a lengthy paper by B. Aronheim. The author has also accomplished the synthesis of napthalene.—Under the heading, "Researches from the Chemical Laboratory of Kasan, communicated by Alexander Saytzeff," we have the following papers:—On an isomeric pyrotartaric acid, by A. Tupoleff. The acid is ethyl-malonic acid.—On the ether of monobrombutyric acid, by the same.—On some sulphur derivatives of the primary butylic alcohols, by N. Grabowsky and Alexander Saytzeff.—On the reduction of succinyl chloride, by A. Saytzeff. The chief product of the reduction is succinic aldehyde $\begin{matrix} CH_2COH \\ | \\ CH_2COH \end{matrix}$ which, by the action of caustic bases, yields a new oxybutyric acid $\begin{matrix} CH_2CH_2OH \\ | \\ CH_2COOH \end{matrix}$.—Contributions towards the determination of the structural formulæ of the allyl compounds of acrylic acid, by E. Linnemann.—Contributions to the history of the orcins.—IV. On the iodo-derivatives of the orcins, by John Stenhouse. This paper has already appeared in the Proceedings of the Royal Society.—Researches on the allyl group.—XIII. On α-dibrompropionic acid, by O. Philippi and B. Tollens.—XIV. On α-monobromacrylic acid and conversion of α-dibrompropionic acid into the β acid, by the same authors.—XV. On β-monobromacrylic acid from β-dibromproprionic acid, by R. Wagner and B. Tollens.—XVI. Bye-products of the preparation of β-monobromacrylic acid, by the same.—F. Mohr contributes a lengthy paper on the theory of dissociation or thermolysis. Among other views the author opposes in severe terms that of Horstmann, who has introduced the idea of entropy into the theory of dissociation.—The concluding paper is by J. J. van Renesse, On octylic and caprylic acids.

Bulletin de l'Academie Royale des Sciences, &c., de Belgique, sér. 2, t. xxxvii., No 4.—Mr. A. Gilkinet gives the first of a promised series of papers on the morphology of the Pyrenomycetes. This instalment of twenty-three pages with two plates is occupied with *Sordaria fimicola* (Cesati and De Notaris), which he identifies with *Sphaeria equina* (Fuckel). His observations confirm those made by M. Woronin on *Sordaria fimiseda*, showing that these fungi are sexual. The development and structure of the male and female organs are minutely given.—Dr. F. Putzeys contributes a paper On the centres of vaso-motor nerves. Where are the nerve-centres which affect the tonicity of blood-vessels? is the question he endeavours to solve. His experiments made upon a frog are carefully detailed. He shows that its spinal marrow posseses a reflex vaso-motor power throughout its entire length, thus confirming the work of Schlesinger, Goltz, Freusberg, and Vulpian. Until lately the tonicity of blood-vessels was believed to be under the control of the medulla oblongata alone.—There is a short note by M. Edward Morren, On the application of the mechanical theory of heat to the growth of plants. M. Barthélemy, Professor of Physics at Toulouse, had recently said that he noticed last July a bamboo in the Jardin des Plantes at Montpellier, which grew a centimetre an hour. Such growth, he remarked, must be coincident with the fixture of carbon. M. Morren by no means sees that this follows. He says, "Carbon fixed in the green organs of plants under the influence of the sun's rays, by the decomposition of carbonic acid, is not immediately applied to the formation of the tissues by which new organs are formed. The materials of growth are furnished by organic material already elaborated, and their application to the requirements of growth is accompanied by an expenditure of force requisite for their circulation and transformations." Often when we can see plants growing they are not fixing any carbon. Tubers, bulbs, buds, and seeds when sprouting not only do not fix carbon, but lose some. This is in consequence of their respiration, and it is the heat furnished by this combustion which occasions the motions by which they sprout.—There are four chemical papers by M. Louis Henry: On the dry distillation of lactic acid; On propargyl; On chloro-bromo-propionic acid; On glycerine derivatives.—There is also a note On systematic international meteorological observations.

Zeitschrift der Osterreichischen Gesellschaft für Meteorologie.—No. 8 of vol. ix. contains papers by Messrs. Wild, Hany, and Jelinek on methods of reduction to sea-level of barometric readings.—Dr. Ebermayer concludes his notice of Lorenz and Rothe's new "Handbook of Climatology." The second volume is by Dr. Lorenz alone. The "Provinces" into which he proposes to divide Europe are Subarctic, Pontic, Baltic, North and South Oceanic, and Mediterranean. The causes of modifications of climate are discussed and grouped according to their relative importance, and though the greater part is devoted to Europe, a short sketch of characteristics of climate of Asia, Africa, America, and Australia is given.—The space devoted to short articles is occupied with a notice of Bruhn's meteorological observations at Leipzic.

Astronomische Nachrichten, Nos. 1,991, 1,992.—These numbers contain a long paper by E. Schönfeld, giving the periods of maximum and minimum of a number of variable stars, with a short history of each. The elements of planet (136) are given as follows:—

Epoch April 1874, 0·0 Berlin time.

$M = 225° 29' 2''$
$\pi = 331° 0' 0''$
$\Omega = 185° 53' 4''$
$i = 11° 30' 4''$
$\phi = 8° 23' 2''$
$\mu = 1007''·86$
Log. $a = 0·36442$.

Memorie della Societa degli Spectroscopisti Italiani, March.—This number contains a letter of Prof. B. Wolf, On the maxima and minima of solar spots. He refers to the value 11·111 years for the period, as given by him in 1852, and now finds from further data the period of minima to be 11·114 years, and that of maxima 11·060 years. He claims to have proved the connection between the above periods, and the magnetic and auroral disturbances. A diagram accompanies this number of the chromosphere, for Sept. 1872, and J. Tacchini contributes a paper On some spectroscopic considerations, in which he gives the method he employs for viewing the prominences with a tangential slit, accompanied by drawings.—To this number is an astronomical appendix, containing a paper by Prof. Schiaparelli, On the eleven-year period of the variation of terrestrial magnetism, considered in relation to the frequency of solar spots, to which is added a table showing at once the connection of the two phenomena, from the year 1836.

Der Naturforscher, April. This number consists of *resumés* of papers read before Societies, &c., most of which we have already noticed. Students of the Prehistoric period will find a long article from the *Mittheilungen der Antiquarischen Gesellschaft in Zürich*, on art workmanship of the reindeer period in Switzerland.

Bulletin de la Société d'Acclimatation de Paris, May.—A very practical paper on acclimatisation opens the May number, in which M. J. M. Cornély gives an account of his experiments in inducing kangaroos, wombats, llamas, marmots, Angora goats, and several new varieties of birds and plants to find a congenial home in the soil and climate of France. The former animals would seem to be fully acclimatised, and promise to be a valuable acquisition.—Brazil now seems to enter into the competition with new varieties of silkworms, which are described as possessing many qualities which will render them a most useful addition to the various silkworms now under cultivation.—The Society has been successful in securing two specimens of a fish called the Gourami, from Singapore; attempts have been made to procure some of these fish for introduction into this country, but they have as yet been unsuccessful. The introduction of the *Diospyros*, a Chinese fruit-tree, is recommended, and attempts are being made to acclimatise it.—M. Millet is endeavouring to secure some means of foretelling the approach of cold weather in the spring months, and asks for any observations on the point which others may have made.—An interesting paper by M. J. Lapru, on the Italian bee, points out the superior qualities of that insect, and suggests its more general cultivation.

Jahrbuch der kais. kön. geologischen Reichsanstalt. Band xxiii. Nos. 3 and 4.—The first paper in No. 3 is by Dr. O. Feistmantel On the relation of the Bohemian carboniferous formation to the permian. The palæontological and physical evidence enables the author to arrange these formations as follows:—I. Permian formations. *a* Upper group (with two stages) consisting of red sandstone with bituminous shales, containing animal remains, and red shales with various plant-remains; marl, limestone, and calcareous shales with abundant animal remains. *b* Lower group, or permanent coal-bearing group, containing coal-seams, generally accompanied with bituminous shales. The beds yield permian animal remains, and a rich flora almost entirely non-carboniferous. Red sandstones with *auracarites* are also included in the group. II. Carboniferous formation: grey sandstones and carboniferous shales; coal-seams without accompanying bituminous shales, and without a fauna which can be brought into relation or connection with the permian. The flora shows no admixture of permian types.—In the second article I. Niedzwiedzki gives some account of the basalt rocks met with in the carboniferous basin near Moravian Ostraw; and the other papers in the number are On the occurrence of Tertiary formations in the upper region of the Maritza valley, that is, between the Balkan and the Rhodope mountains in Rumili; and Contributions to the geology of the Fruska Gora in Syrmia.—There are only two geological papers in No. 4, the first of which is a very long contribution by F Posepny, On the lead and cadmia veins of Raibl in Carinthia, which is well illustrated with coloured lithographs, showing sections of various vein-stores, ores, minerals, &c., and a map of the workings, &c.—The second paper is by Dr. Mojsisovics, On some triassic fossils from the South Alps; two plates accompany the paper.—Among the "Mineralogical Communications," so carefully edited by Dr. Tschermak, there is one paper of somewhat general interest, An outline of a mechanical theory of the laws of crystallisation, by Dr. J. Hirschwald.

Verhandlungen des naturhist. Vereins d. pr. Rheinlande u. Westpholens, 29ter u. 30ter Jahrgang.—The former of these volumes contains, among other papers, one On Vesuvius, by Von Rath and Von Lasaulx; On the structure of Trilobites, by Von Koenen; On the effect of extreme cold on plants, by Mohr; On *Monas prodigiosa*, by Prof. Binz of Bonn; On the pupil of the fox, by Troschel; On benzyl-sulpho-cyanates, by Kekulé; and others on technical points of medicine. In the latter we may note Dr. Braun's description of the Upper Jura, with a geological section; Dr. Umber's measurements of the skulls of numerous mammalia, in which he attempts to find a criterion of their intelligence in the proportion of the anterior to the posterior part of the basis cranii (according to his results the Carnivora are inferior to the Quadrumana; and Horses to Rodents and Marsupials); two papers on the geological and palæontological features of the cave at Balm: one by Rindfleisch On tubercular inflammation; and one by Kekulé On allyl compounds.

SOCIETIES AND ACADEMIES

LONDON

Royal Society, June 11.—Note on the alleged existence of Remains of a Lemming in Cave-deposits of England, by Prof. Owen, F R.S.

Note on the Absorption-spectra of Potassium and Sodium at low temperatures, by H E Roscoe, F.R.S., and Arthur Schuster.

In order to obtain the absorption-spectrum afforded by the well-known green coloured potassium vapour, pieces of the clean dry metal were sealed up in glass tubes filled with hydrogen, and one of these was then placed in front of the slit of a large Steinhill's spectroscope, furnished with two prisms having refracting angles of 45° and 60° The magnifying power of the telescope was 40, and was sufficient clearly to separate the D lines with one prism. A continuous spectrum from a lime-light was used, and that portion of a tube containing the bright metallic globule of potassium was gently heated until the green vapour made its appearance. A complicated absorption spectrum was then seen, a set of bands (α) in the red coming out first, whilst after a few moments two other groups appeared on either side of the D lines, the group β (less refrangible) being not so dark as the group γ. These bands are all shaded off towards the red, and in general appearance resemble those of the iodine spectrum. In order to assure ourselves that the bands are not caused by the presence of a trace of an oxide, tubes were prepared in which the metal was melted in hydrogen several times on successive days until no further change in the bright character of the globule could be perceived. On vapourising the metal, which had been melted down to a clean portion of the tube, the bands were seen as before, and came out even more clearly, the globule, after heating, exhibiting a bright metallic surface. An analysis of the potassium used showed that it did not contain more than 0·8 per cent. of sodium, although, of course, the double line D was always plainly seen.

In order to ascertain whether an alteration in the absorption-spectrum of the metal takes place at a red heat, fragments of potassium were placed in a red-hot iron tube, through which a rapid current of pure hydrogen gas was passed, the ends of the tube being closed by glass plates. The magnificent green colour of the vapour was clearly seen at this temperature on looking through the tube at a lime-light placed at the other end. Owing, doubtless, to the greater thickness or increased pressure of the vapour, the bands seen by the previous method could not be resolved by the small spectroscope employed, the whole of the red being absorbed, whilst a broad absorption-band in the greenish yellow was seen occupying the place of the group γ.

The positions of the bands obtained by the first method were measured by means of a telescope and distant scale, and the wave-lengths obtained by an interpolation curve, for which well-known air-lines were taken as references. The following numbers give the wave-lengths of the most distinct, that is, the most refrangible edge of each band. As the measurements had to be quickly made owing to the rapid darkening of the glass by the action of the metallic vapour, these numbers do not lay claim to very great accuracy, but fairly represent the relative positions of the band, and show that they do not always occur at regular intervals, although they are pretty regularly spread over the field, and all are shaded alike.

Bands of potassium shaded off towards red. Wave-length in tenth metre:—

6844		6459		6311		5949		5763	
6762		6430		6300	α	5930	β	5745	
6710		6400		6275		5901		5732	
6666		6379		6059		5860		5712	
6615	α	6357	α	6033		5842		5700	γ
6572		6350		6012	β	5821	γ	5690	
6534		6331		5988		5802		5674	
6494		6322		5964		5781		5667	

The bright potassium lines in the red and violet were not seen reversed, the intensity of the lime-light being too small at both extremes to render an observation possible.

In order to ascertain whether the vapour of sodium, which, when seen in thin layers, appears nearly colourless, exhibits similar absorption-bands, tubes containing the pure metal, which had been prepared and preserved out of contact with any hydrocarbon, were prepared, the metal being obtained free from oxide and the absorption-spectrum being observed in the manner already described. As soon as the metal began to boil a series of bands in the blue (Na γ) made their appearance, and shortly afterwards bands in the red and yellow (Na α), stretching as far as the D lines, came out. At this period of the experiment the D lines widened, thus blotting out a series of fine bands occurring in the orange (Na β), some of which could in consequence not be mapped. All the bands of the sodium-spectrum shade off like the potassium bands towards the red.

When the vapour of sodium is examined in a red-hot iron tube the colour of the lime-light as seen through it is a dark blue. As the sodium is swept away by the current of hydrogen passing through the colour becomes lighter, and the transmitted rays can be analysed by the spectroscope. At first the whole red and green and part of the blue is cut out entirely. The D lines are considerably widened, and an absorption-band is seen in the green, apparently coinciding with the double sodium line, which comes next in strength to the D lines. All the colours, therefore, seem to be shut out except part of the orange, part of the green, and the ultra blue. As the sodium vapour becomes less dense more light passes through, and the same absorption-bands are seen as are observed in the other method. The vapour then has a slight bluish-green tint, but is nearly colourless.

The following numbers give the wave-lengths of the more refrangible edge of the sodium absorption-bands in tenth-metres obtained in the manner above described :—

6668		6361		6105		5999 β	4964	
6616		6272		6092		5150	4927	
6552	α	6235	α	6071	β	5129	4889	γ
6499		6192		6051		5082 γ	4863	
6450		6162		6035		5038	4832	
6405		6149		6016		5002	4810	

The drawings accompanying the paper show the general appearance of the two absorption-spectra.

Linnean Society.—Anniversary Meeting, May 25.—G. Busk, vice-president, in the chair.—The chairman announced the officers who had been elected for the year (see NATURE, vol. x. p. 72).—It was moved by Mr. Busk, seconded by Mr. Carruthers, and carried unanimously :—" That the secretaries be requested to convey to Mr. Bentham the cordial thanks of the Society for his invaluable services throughout the thirteen years during which he has occupied the president's chair, to express to him the regret with which the Fellows contemplate the loss of his services, and to assure him that the zealous interest which he has taken in the welfare of the Society and the great efforts which he has made with so much liberality and success, to increase its prosperity and usefulness will always be held in grateful remembrance."—It was moved by Mr. Busk and unanimously resolved :—" That the thanks of the Society be also given to Mr. Stainton on his retirement from the office of secretary, with an expression of the Society's deep regret on losing his valuable services in that capacity."

June 4.—Mr. G. J. Allmann, president, in the chair.—The president exhibited a number of living specimens of fire-fly (*Luciola italica*) recently taken by himself in the neighbourhood of Turin, calling attention to the remarkable synchronous emissions of flashes of light by numerous individuals, and pointing out that the phosphorescence is a phenomenon not of darkness merely, but of twilight or night.—Prof. Thiselton Dyer described the structure of the flowers of *Pringlea* and *Lyallia*, which had recently been sent to this country for the first time by Mr. Moseley, from Kerguelen's Land, and which had been analysed by Prof. Oliver, and subsequently by himself. Dr. Hooker pointed out that several peculiarities in the structure of *Pringlea*, the absence of petals and of the usual glands between the bases of the stamens, the exserted anthers, and the papillæ of the stigma extended into a tuft of hair, appeared to point to this plant (a native of a country where there are no winged insects), being a wing-fertilised member of a class of plants that are ordinarily fertilised by insects.—The following papers were then read :—1. Contributions to the botany of the *Challenger* expedition. Presented by Dr. J. D. Hooker, C.B.—XII*a*. *Challenger* Lichens (Cape de Verdes), by Dr. J Stirton.—XVII*a*. Letter from Mr. H. N. Moseley to Dr. Hooker, dated Cape Otway, Australia, March 16, On the botany of Kerguelen's Land, Marion, and Heard Islands.—XVIII. List of hitherto unrecorded species from Kerguelen's Land, Marion, and Heard Islands, with a note on *Lyallia kerguelensis* Hook f., by Prof. Oliver.—Synopsis of the mosses of the Island of St. Paul, by W. Mitten (Appendix to Dr. Hooker's paper On St. Paul's Island plants).—On the Restiaceæ of Thunberg's herbarium, by M. T. Masters, F.R.S. At the time that the author published his monograph On the South-African Restiaceæ, in the Journal of the Society, vol. viii. p. 211, and vol. x. p. 209, he had had no opportunity of examining the type specimens described by Thunberg. The few figures published by that naturalist are excellent ; but his descriptions are often so imperfect that not even the sex of the plant is mentioned. In common therefore with all who had previously studied these plants, the author had to guess at the species intended by Thunberg. Lately, however, by the kindness of the authorities at Upsal, Thunberg's African collections have been transmitted to Kew for examination, and the author availed himself of the opportunity to study the Restiaceæ. The paper now read contains a list of these specimens with their names, synonyms, and such rectifications in the nomenclature as the examination rendered necessary.—On *Napoleona*, *Omphalocarpum* and *Asteranthos*, by J. Miers. The plants forming the small group of the *Napoleoneæ* are confined to two very heterogeneous genera, one from Africa, the other from Brazil. *Napoleona* was discovered in 1787 at Owaree, by Palisot-Beauvois ; *Asteranthos* was established in 1820 by Desfontaines, when he associated it with *Napoleona* as a group belonging to *Symplocineæ*. These plants have been ever since a complete puzzle to botanists, who have assigned to them remotely dissimilar positions, the last being that given by the authors of the "Genera Plantarum," who make them a sub-tribe of Lecythideæ, one of their tribes of Myrtaceæ. A careful examination of these plants has convinced the author that most botanists have been wide of the mark in regard to their true affinity. Mr. Miers brought forward a large mass of information concerning *Napoleona*, from which he drew the conclusion that there is nothing in its structure to show the slightest relation to Myrtaceæ ; that it is equally irreconcilable with the Barringtonieæ and with Lecythideæ ; and in consequence of these negative results we must search elsewhere for its true affinity. This led the author to examine *Omphalocarpum*, a genus from the same region as *Napoleona*, and whose flowers and fruit of similar form grow upon the trunk of the trees. This genus has been generally regarded as belonging to Sapotaceæ ; but the authors of the "Genera Plantarum" place it in Ternstrœmiaceæ. *Napoleona* cannot, it is true, belong to Sapotaceæ ; but as it offers so many points of resemblance, and as it cannot find a place in any known natural order it must remain the monotype of a distinct family, to be placed in juxtaposition with Sapotaceæ. In regard to *Asteranthos* the author shows by analytical figures that it bears scarcely any resemblance in any of its features to *Napoleona*. A strong resemblance exists in the form of its calyx to that represented by Wight in an Indian species of *Rhododendron*. And there seems nothing therefore to separate *Asteranthos* from other genera of Rhododendreæ, except its more rotate corolla.

Mathematical Society, Thursday, June 11.—Dr. Hirst, F.R.S., president, in the chair.—The president made a statement to the effect that he had much pleasure in announcing to the members present that he had received a letter from Lord Rayleigh in which that gentleman expressed his intention of handing over to the Society the sum of 1,000*l*. to be invested and applied to assist in the publication of the Proceedings, and the purchase of mathematical periodicals. As the subject will be brought before the members more fully in November next, no further action was taken, but the announcement of the munificent offer gave general satisfaction to the meeting.—Prof. Cayley, F.R.S., V.P., having taken the chair, Mr. S. Roberts gave an account of his paper On the parallels of developables and of curves of double curvature.—Lord Rayleigh next read a note On the numerical calculation of the roots of fluctuating functions.—In the absence of the authors, the secretary read parts of papers by Mr. Griffiths and Mr. Routh, F.R.S In his note On a remarkable relation between the difference of two Fagnanian arcs of an ellipse of eccentricity e, and that of two corresponding arcs of a hyperbola of eccentricity $\frac{1}{e}$ Mr. Griffiths establishes the following relation: $\frac{\text{arc } PP_0 - \text{arc } QQ_0}{\text{arc } P'P_0' - \text{arc } Q'Q_0'} = e^3 x x' \xi \xi'$, where the unaccented letters refer to the ellipse and the accented letters to the hyperbola, and x, ξ, x_0, ξ_0 are the abscissæ of P, Q, P_0, Q_0. The object of Mr. Routh's first paper, viz. Stability of a dynamical system with two independent motions, will be gathered from the following extract :—" The equations of motion of a dynamical system performing small oscillations with two independent motions are of the form

$$A\frac{d^2x}{dt^2} + B\frac{dx}{dt} + Cx + F\frac{d^2y}{dt^2} + G\frac{dy}{dt} + Hy = 0$$

$$A'\frac{d^2x}{dt^2} + B'\frac{dx}{dt} + C'x + F'\frac{d^2y}{dt^2} + G'\frac{dy}{dt} + H'y = 0$$

To solve these we eliminate either x or y, and obtain a quadratic of the form

$$aD^4 + bD^3 + cD^2 + dD + e = 0$$

The whole nature of the motion depends on the forms of the roots of this equation. Rules are given in books on the theory of equations to determine whether the roots are real or imaginary, but this is not exactly what we want to know. It is often important to ascertain whether the equilibrium about which the oscillation takes place is stable or unstable. The necessary and sufficient conditions for stability are that the real roots and the real parts of the imaginary roots should all be negative. It is proposed to investigate a method of easy application to decide this point." Mr. Routh's second paper was On rocking stones, and a third was On small oscillations to any degree of approximation.

Anthropological Institute, June 9.—Prof. Busk, F.R.S., president, in the chair.—Sir John Lubbock, Bart., read a paper On the discovery of stone implements in Egypt. The author began with a sketch of the writings and opinions of M. Arcelin and Dr. Hamy, who maintained that the flint implements found along the valley of the Nile, including a hatchet of the St. Acheul type at Deir-el-Bahari, indicated the existence formerly of a true stone age there as in Western Europe. MM. Mortillet and Broca concurred in that view.—On the other hand Dr. Pruner-Bey, and especially Dr. Lepsius, had expressed the opinion that most of the objects described, such as the flint flakes, were naturally produced. M. Chabas also took the same view as Dr. Lepsius, and denied the existence of any evidence of a stone age either in Egypt or elsewhere. On the occasion of a late visit to Egypt with the object of getting conclusive personal evidence on the question, the author found worked flints at various spots along the Nile Valley, especially in the valley of the tombs of the kings of Thebes, and at Abydos, and after carefully weighing the facts and arguments brought forward by MM. Lepsius and Chabas, he was disposed to agree with MM. Arcelin and Hamy in considering that these flint implements really belonged to the stone age, and were ante-Pharaonic. Sir John exhibited a full series of the Egyptian flint implements found by himself during his visit, and the paper concluded with a minute description of each specimen.—Prof. Owen, F.R.S., then read a paper On the ethnology of Egypt. Since the observations recorded in 1861, by Dr. Pruner-Bey, on the race-characters of the ancient Egyptians, mainly based on the characters of skulls, evidences, in the author's opinion, of a more instructive kind have been discovered, chiefly by M. Mariette-Bey. They consist of portrait-sculptures, chiefly statues, found in tombs accompanied by hieroglyphic inscriptions revealing the name, condition, and date of decease. A study of those works led to the conclusion that three distinct types were indicated. (1) The Primal Egyptian, bearing no trace of negro or Arab, but more nearly matched by a high European facies of the present day. (2) The type of the conquering race of Shepherd Kings, or Syro-Arabian, exemplified in the Assyrian sculptures. (3) The Nubian Egyptian, typified in the bas-relief figure of Cleopatra in the Temple of Denderah. In conclusion, the professor drew a graphic picture of the high state of civilisation attained by the Primal Egyptian race, whose exquisite works, done six thousand years ago, are now rendered accessible to man. The paper was amply illustrated by a series of photographs, maps, and diagrams.

Royal Horticultural Society, June 4.—Scientific Committee.—A. Grote, F.L.S., in the chair.—The Rev. M. J. Berkeley exhibited trusses of Pelargonium "St. George," in which all the flowers, and not the central one only, were destitute of spur, thus presenting an illustration of what is termed regular Peloria, and approximating to the genus Geranium.—Messrs. Veitch sent a coffee-bush from Ceylon affected with a fungus, which overruns some 1,000 acres of plantation. This was probably the *Hemileia vastatrix*.—Mr. A. Murray alluded to the moth, *Pronuba yuccasella*, which has the habit of gathering the pollen of *Yucca*, and in so doing often fertilises the stigma.—Dr. Masters showed the roots of a Deodar, which had suddenly died after having been planted about fourteen years. On examination the plant was found infested by mycelium, and on further inquiry it was ascertained that the tree had been planted on the site of an old tan-pit, which had doubtless furnished the nidus for the spawn.—Prof. Thiselton Dyer read the following extract from a letter addressed to Admiral Spratt by his son:—"Dalhousie, Feb. 22, 1874.—On the night of the 10th of this month we had a change of white to blood-looking snow. The native mind was much excited, and said this falling of blood and snow was a sign of some coming great war. The blood and snow was snow mixed with dust. Now as the whole of the hills at the foot for some distance had been for many days well saturated, this dust must have come from a long distance, and must have ascended a considerable height. The snow-cloud must have been full of dust, or the atmosphere between us and it, probably the latter. The amount of discoloured snow was ¾" and the contents of one superficial foot 12¼ grains. Under the microscope it looked like small transparent laminations of mica or silica."—Prof. Thiselton Dyer communicated a note on the temperature of hill and dale.

General Meeting.—W. A. Lindsay in the chair.—The Rev. M. J. Berkeley commented on a new hybrid *Sarracenia*, raised between *S. flava* and *S. purpurea*, also on a plant of *Amorphophallus Berkeleyi*, found at Rangoon by his son Capt. Berkeley, and the stems of which were said to be sold in the Indian markets like asparagus.

Paris

Academy of Sciences, June 8.—M. Bertrand in the chair.—The president announced the death of M. Roulin, librarian to the Academy, and principal editor of the first volumes of the *Comptes Rendus*.—The following papers were read:—Determination of the number of similar triangles which satisfy four conditions, by M. Chasles.—On the distribution of the heat developed by collision, by M. Tresca. The author was led to this research by observing the production of oblique luminous streaks on the lateral faces of the platinum-iridium bar (described at the last meeting by General Morin) during the process of forging.—Several communications on vine-culture were read, all relating to *Phylloxera*. The first of these was by M. Dumas, entitled "Memoir on the means of repelling the invasion of *Phylloxera*." The author considers ammonium sulphhydrate the safest substance for the destruction of the pest without injuring the vine.—On the progress of the vine disease during winter. On the practical means of opposing the disease, by M. H. Marès. The author advocates likewise the use of ammonium sulphhydrate.—On the employment of carbon disulphide to repel *Phylloxera*, by M. le Baron de Chefdebein.—On the employment of sand in the treatment of vines attacked by *Phylloxera*, extract from a letter from M. J. Lichtenstein to M. Dumas. It appears that the insect cannot make way through sand owing to the loose nature of this substance. Since sand contains no fertilising principle, it is proposed to mix it with ashes and guano. The extract concludes with the following advice:—"Surround your stocks largely with sand, *Phylloxera* will not come, or, if there, it will perish and your vines will recover."—Prof. Cayley communicated a note entitled, "On a Formula of Unlimited Integration."—On the age and position of the Saint-Béat marble, a geological note, by M. Leymerie.—On the minute motions of a material system in stable equilibrium, by M. F. Lucas.—Modification of the commutator of Clarke's machine, by M. A. Barthélemy.—On friction in the collision of bodies, by Mr. G. Darboux.—On the lines of curvature of ruled surfaces, by M. E. Weyr.—Note on the spectrum of Coggia's comet (1874 III.), by M. G. Rayet. The spectrum is continuous from the orange to the blue (spectrum of the nucleus) and is traversed by three bright bands (spectrum of the coma) in the yellow, green and blue.—On the motion of the air in pipes, by M. Ch. Bontemps.—On a physiological peculiarity of Axolotl, by M. C. Dareste. The peculiarity in question is the presence of a mucous substance more or less red and containing blood corpuscles in the cloaca of both sexes during the period of reproduction.—On the metamorphoses of the *Acari* of the families *Sarcoptidæ* and *Gamasidæ*, by M. Mégnin.

CONTENTS