therefore under the necessity of lecturing twice a day. His retirement from Glasgow College has opened the way for a young botanist of great promise, Dr. I. Bayley Balfour, son of the veteran professor at Edinburgh, who has been appointed by the Crown to the vacant chair. Dr. Balfour took the degree of Doctor of Science in Botany some years ago with great distinction at Edinburgh. He was selected by the Council of the Royal Society to accompany the recent Transit of Venus Expedition to Rodriguez for the purpose of making a scientific examination of that island. As the result of his researches, besides the report on the natural history, which he has sent in to the Royal Society, he has produced an excellent paper on the genus *Halophila*. Having had considerable experience in class-work under his father, as well as under Professors Huxley and Sir Wyville Thomson, he enters on his new duties with many advantages. Whether as an original investigator or as a successful teacher, he will, we doubt not, fully sustain the reputation of the Glasgow University.

WE are glad to notice that the School Board for London have decided that it would be expedient to include the elements of natural science among the recognised subjects of class examination. The object of this resolution is to transfer what is called elementary science from the category of specific subjects into the category of class subjects. At present there is little inducement for pupils to take science subjects, nor will there be until it be included in the regular course of instruction in elementary schools. We hope the memorial which the Board is to prepare will be treated with the attention it deserves.

SOCIETIES AND ACADEMIES

LONDON

Royal Society, May 8.—"On the Sensitive State of Electrial Discharges through Rarefied Gases." By William Spottiswoode, P.R.S., and S. Fletcher Moulton, late Fellow of Christ's College, Cambridge.

It has frequently been remarked that the luminous column produced by electric discharges in vacuum tubes sometimes displays great sensitiveness on the approach of the finger, or other conductor, to the tube. This is notably the case when with an induction coil a very rapid break is used, or when with any constant source of electricity an air-spark is interposed in the circuit leading to the tube. The striking character of the phenomena, and the opportunity which they showed for affecting the discharge from the outside during its passage, led the authors of this paper to consider that a special examination of this sensitive state would be desirable.

All the circumstances under which sensitiveness is produced appear to agree in requiring, first, that there should be a rapid intermittance in the current leading to the tube; and secondly, that the individual intermittent discharges should be small in quantity and extremely brief, if not instantaneous, in duration. Both these requirements are fulfilled by the methods used in the present investigation, viz., a Holtz machine with a suitable air-spark between the machine and the tube, and a small coil with a rapid break.

If a conductor be made to approach a tube conveying a sensitive discharge, due to an air-spark in the positive branch of the circuit, a series of effects is produced, of which the feeblest and the strongest are the most pronounced. The transition from one to the other is so rapid that the intermediate phases may be easily overlooked. In the first case, the luminous column is repelled by the conductor; in the second it is broken into two parts which stretch out in two tongues towards the point on the tube (P) nearest the conductor, while a negative halo appears between them.

That these effects are due to the inductive action of the conductor, or more particularly to re-distributions of electricity in it, co-periodic with the air-spark, and not to any permanent charge, is shown by the following experiments. A non-conductor, whether charged or not, is without effect. The effect of a conductor increases with its size or capacity, and with its proximity to the tube, until the fullest effect (viz., that given by an earth connexion) is produced. That the effects are not due to electrodynamic, or to magnetic action, is shown by the fact that a coil of wire produces the same result, whether the ends be joined or not. The effects of an iron core and helix with open ends are often comparable with, and sometimes equal to, those when the ends, being connected with a battery, the whole becomes an electro-magnet. The effect upon the interior is, in fact, due to the relief given by the conductor to the electric tension on the outer surface of the tube and the space around it, caused by the individual discharges.

Instead, however, of connecting a point (P) on the tube with a large conductor or with earth, we may connect it with one or other terminal of the tube. And a further study of the subject shows that all the phenomena due to action from without may be produced by means of one or other of these connexions. Connexion with the non-air-spark terminal gives the relief effects described above; connexion with the air-spark terminal gives another set of effects. Of these the feeblest has the appearance of attraction, while the strongest shows an abrupt termination of the positive column in the neighbourhood of the point (P), followed by a negative halo, and then by a recommencement of the positive column in the direction of the negative terminal. Each of these sectional discharges is in fact independent and complete in itself, and they are due to impulses of positive electricity thrown into the tube from the air-spark. At the positive terminal these impulses are thrown directly in; at the points of connexion they are due to induction, *ab extra*. The negative part of what was originally neutral meets the positive column, and satisfies it as it arrives, while the positive leaps forward to meet the negative due from the negative terminal.

The effects above described need not be confined to a single patch or ring of conducting material placed upon the tube; but they may be produced many times over in the same tube by a series of rings arranged at suitable distances. By this means the column may be broken into a series of sections, all terminating with well-defined configurations towards the negative end, and having greater or less length, according to the position of the rings. In the paper itself, arguments are there brought forward showing that these sectional discharges represent striæ not merely in their appearance, but also in their function and structure. But the discussion could hardly be produced within the limits of an abstract.

Returning from the digression about striæ, the authors next give evidence, derived mainly from the revolving mirror, and from the discharges of a partially charged Leyden jar, for the following conclusion: That the passage of the discharge occupies a time sufficiently short in comparison with the interval between the discharges to prevent any interference between successive pulses. Certain experiments are then described which indicate that the discharge is effected, under ordinary circumstances, by the passage through the tube from the air-spark terminal of free electricity, of the same name as the electricity at that terminal. In the case of an induction coil, where the air-spark must be considered as existing at both terminals, there is evidence of a *neutral zone*, where the sensitiveness disappears. The position of this zone may be altered by damping the impulses at either terminal; or it may be abolished by connecting one terminal with earth. The impulses may even be so distributed as to divide electrically a single tube into three sections, the two extremes presenting visible discharges, with a dark section between them.

Looking at all these phenomena from an opposite point of view, we may, by means of the relief effects, determine the terminal from which a discharge proceeds, and the distance to which it reaches without provoking a response from the other. And through these considerations, together with others detailed in the paper, the authors are led to the conclusion that the discharges at the two terminals of a tube are in the main independent, and that they are each determined primarily by the conditions at their own terminal, and only in a secondary degree by those at the opposite terminal.

In illustration of this view, an account is then given of the production of unipolar, positive, or negative discharges in a tube. In such cases, the discharge being insufficient of itself to pass through the tube, returns by the way by which it entered.

This closes a series of experiments, the result of which is that the discharges from the two terminals can be made of equal intensity, or of any required degree of inequality; or the discharge can be made to issue from one terminal only, the other acting only receptively; or it can be made to return into its own terminal, while the other takes no part in the discharge; or, finally, the two terminals can be made to pour out independent discharges of the same name, each of which returns to its own terminal.

Having traced the relation between the two parts of the discharge, and having found means for controlling their range and influence, the authors were led to inquire whether there be any experimental evidence of the state of the tube during the occurrence of the discharge. Some experiments with two pieces of

tinfoil of unequal size placed near the ends of the tube and metallically connected, and others with a strip of tinfoil placed along the tube, all gave effects showing that the discharge cannot be simultaneous throughout the tube. The phenomena appear to require for their interpretation that, in front of the pulse coming from the (positive) air-spark terminal, there is, during the interval between the pulses, a rising negative potential. This is entirely swept out by the pulse as it advances along the tube, after which the process is repeated. The condition of things behind the pulse is more difficult to determine, but an experiment with the telephone gives reason to think that parts of the tube nearer to the non-air-spark end are in a condition to demand relief, before those nearer to the air-spark terminal have ceased to require it. And on this account the discharge may, perhaps, be more nearly represented by a lazy tongs than by a bullet.

How far the results obtained from the sensitive state are applicable to ordinary discharges is a question which cannot yet be definitively answered. But the marked similarities in the phenomena, and the predisposing circumstances of striation or non-striation, as well as in the terminal peculiarities of the two kinds of discharge, point strongly to the conclusions that all vacuum discharges are disruptive; and that sensitive differ from non-sensitive discharges mainly in the scale of the discontinuity due to the disruptiveness, causing a difference between the two classes of phenomena analogous to that between impulsive and continuous forces in dynamics.

Mathematical Society, May 8.—Mr. C. W. Merrifield, F.R.S., president, in the chair.—Messrs. A. J. C. Allen and E. Anthony were elected Members.—The following communications were made:—On the complex whose lines join conjugate points of two correlative planes, Dr. Hirst, F.R.S.—Note on a geometrical theorem connected with the function of an imaginary variable, Prof. Cayley, F.R.S.—Some definite integrals, the late Prof. Clifford, F.R.S.—A method of constructing, by pure analysis, functions X, Y, &c., which possess the property that $\int X Y d\sigma = 0$, and such that any given function can be expanded in the form $\alpha X + \beta Y + \gamma Z + \ldots$, Mr. E. J. Routh, F.R.S.—The numerical calculation of a class of determinants, and a continued fraction, Mr. J. D. H. Dickson.—On the inscription of the regular heptagon, Rev. Dr. Freeth.

Zoological Society, May 6.—Prof. W. H. Flower, F.R.S., president, in the chair. A letter was read from Mr. E. L. Layard, F.Z.S., relating to the localities of certain species of Fruit-Pigeons (*Ptilopus*) of the South Pacific Islands.—Prof. Flower, F.R.S., exhibited and made remarks on a drawing of a British Cetacean (*Delphinus tursio*), taken from a specimen captured near Holyhead in 1878.—A communication was read from Mr. Gerard Krefft, giving the description of a supposed new form of insectivorous Bat, of which a specimen had been obtained on the Wilson River, Central Queensland.—The Rev. Canon Tristram, C.M.Z.S., read a description of a new species of Wood-pecker, from the Island of Tyzu Sima, near Japan, which he proposed to name after its discoverer, *Dryocopus richardsi*.—A communication was read from Mr. F. Moore, F.Z.S., containing the descriptions of new genera and species of Asiatic Lepidoptera Heterocera. Eleven new genera were characterised and ninety new species described.—Mr. G. French Angas, C.M.Z.S., read the descriptions of ten new species of shells of the genera *Axinæa* and *Pectunculus*.—A communication was read from Mr. W. A. Forbes, F.Z.S., on the anatomy of the African Elephant, based on the facts observed during a dissection of a young female of that species during the last winter. The structures of the thoracic, alimentary, and urino-genital viscera of this species were described, and compared with the previously published accounts of those of both the Indian and African species of Elephant. The most important differences observed were those displayed in the liver and female organs, but on the whole were not of such a nature as to make it advisable, in the author's opinion, to separate *Loxodon* as a genus from *Elephas* proper.—A paper was read by Mr. F. Jeffrey Bell, F.Z.S., on the question of the number of anal plates in the Echinoderms of the genus *Echinocidaris*.

Geological Society, April 30.—Henry Clifton Sorby, F.R.S., president, in the chair.—Alfred Stanley Foord was elected a Fellow of the Society.—The following communications were read:—A contribution to the history of mineral veins, by John Arthur Phillips, F.G.S. In this paper the author described the phenomena of the deposition of minerals from the water and steam of hot springs, as illustrated in the Californian region, referring especially to a great "sulphur bank" in Lake County, to the steamboat springs in the State of Nevada, and to the great Comstock lode. He noticed the formation of deposits of silica, both amorphous and crystalline, inclosing other minerals, especially cinnabar and gold, and in some cases forming true mineral veins. The crystalline silica formed contains liquid-cavities, and exhibits the usual characteristics of ordinary quartz. In the great Comstock lode, which is worked for gold and silver, the mines have now reached a considerable depth, some as much as 2,660 feet. The water in these mines was always at a rather high temperature, but now in the deepest mines it issues at a temperature of 157° Fahr. It is estimated that at least 4,200,000 tons of water are now annually pumped from the workings; and the author discussed the probable source of this heat, which he was inclined to regard as a last trace of volcanic activity.—*Vectisaurus valdensis*, a new Wealden Dinosaur, by J. W. Hulke, F.R.S. The characters presented by the genus *Vectisaurus* were stated to be as follows:—Ilium with a long compressed ant-acetabular process, having its greatest transverse extent in a vertical plane, and strengthened by a strong ridge produced from the sacral crest. Vertebræ in anterior dorsal region having opisthocœlous centres, their lateral surfaces longitudinally concave, transversely gently convex, meeting below in a blunt keel.—On the Cudgegong diamond-field, N.S.W., by Mr. Norman Taylor.—On the occurrence of the genus *Dithyrocaris* in the lower carboniferous, or calciferous sandstone series of Scotland, and on that of a second species of *Anthrapalæmon* in these beds, by R. Etheridge, Jun., F.G.S.

CAMBRIDGE

Philosophical Society, May 5.—A communication was made to the Society by Prof. T. McK. Hughes, on the relation of the appearances of life upon the earth to the known breaks in the continuity of the older sedimentary rocks. In his introductory remarks the author explained the manner in which he believed the transference of the area of the growth of sediment took place by gradual depression on one side and elevation on the other, and pointed out that there was stratigraphical evidence of the earlier commencement of the accumulation of a continuous series in one area than another, and that often the direction of the movements could be inferred. To the compulsory migration of species consequent upon these movements he attributed the extinction of those that could not adapt themselves to the new circumstances, the appearance of the colonies described by Barrande, and also the gradual introduction of new forms of life throughout the whole of the sedimentary rocks. The principal part of the paper was upon the last question, the author holding that it was only reasoning in a circle to define formations palæontologically and then to speak of the incoming and outgoing of species as nearly coincident with the beginning and end of the formation. He classified the whole sedimentary series on the principle of grouping together all the sediment continuously deposited in any one area, and indicated by corresponding intervals the period during which there was in that area denudation only, the deposition of the denuded material necessarily going on elsewhere. Then, giving an analysis of the palæontology of the older rocks, he showed that the various forms of life came in gradually as compelled to move, and as their travelling powers allowed them, from adjoining areas where local conditions had become unfavourable, pointing out that they did not generally first appear at the beginning or disappear at the close of any series of continuous deposits, but that new forms kept turning up all through, and that after a long interval, whether measured by denudation or deposition, about the same kind and amount of palæontological change had occurred, the chances being that in so long a time geographical changes had taken place in the surrounding district. He showed that thus the palæontological confirmed the stratigraphical evidence with regard to the persistence of continental as well as of oceanic areas, as the sequence of life on the earth required that there could never have been an interruption in the continuity of suitable land and water. He appealed to physicists to tell us whether chiefly to the transference of such great masses of material always to the coast lines of continents, or to secular cosmical action, or to both, we should refer this persistent creeping of earth folds in various directions at different times.

PARIS

Academy of Sciences, April 28.—M. Daubrée in the chair.—The following papers were read:—On the electric light,

by M. Jamin (see last week's NATURE).—On criticism of experiments undertaken to determine the direction of the pressure in oblique arches, by M. de la Gournerie.—On the choice of moduli in hyperelliptic integrals, by M. Borchardt.—The president of the Venus Transit Committee presented fascicle B of "Documents relating to Measurement of Photographic Negatives." This includes a thorough discussion of the measurements at St. Paul's Island.—Report on a note relative to the embankment of the Tiber at Rome, presented by M. Dausse. Instead of trying to obviate inundations by high quay walls, this engineer recommends a partly natural deepening of the bed, securing continuous navigation. He bases his arguments on results of a system adopted on the Po and elsewhere, in which the river is narrowed by submersible dykes (within insubmersible ones), and by its thus increased velocity insures a sufficient draught of water. In flood-time the water-level is lower than formerly, and the expanded river gives rich deposits in the larger bed beyond the submersible dykes.—On the electrical inscription of speech, by M. Boudet de Paris. A very sensitive microphonic transmitter is used, in which the carbons are simply held in contact by a small piece of paper folded in the form of V. The receiving telephone has diaphragm and cover removed, a spring fixed at one end on the wood, and at the other end (to which is added a small piece of soft iron), resting on the magnet; a light bamboo style with whalebone extremity is attached to the spring, and gives instructive traces on decalcomanic paper.—Observation of the periodic comet II., 1867 (Tempel), made by M. Tempel at Florence Observatory.—On a new form of co-ordinates in the problem of two bodies, by M. Gyldén.—On a class of non-uniform functions, by M. Picard.—Theoretical and experimental demonstration of the following definition of temperature: Temperature is represented by the length of calorific oscillation of the molecules of a substance, by M. Pictet. He verifies these two laws: 1. The higher the points of fusion, the shorter are the molecular oscillations. 2. The temperatures of fusion of solids corresponding to equal lengths of oscillation, and the product of the lengths of oscillation by the temperatures of fusion, should be a constant number for all solids.—Siren with electromagnetic regulator, by M. Bourbouze. An improvement on an apparatus described December 18, 1876; with a pinion and double rack he can simultaneously bring near both electromagnets to the copper disk or remove them, obtaining any note in the siren.—On a mode of continuous registration of the direction of the wind, by M. André. This instrument, constructed by M. Redier, is used at Lyons Observatory.—On the present state of Vesuvius, by M. Semmola. The large crater of 1872 is almost wholly filled up; the new cone of eruption has grown so that it is now on a level with the old crater, and will soon be above it. Lavas are sometimes poured out on the north side, and seen from Naples. Fumeroles of lava are very frequent and lively on the interior walls of the old crater; they are all acid. (The products, &c., are described.)—On the laws of dissociation, by MM. Moitessier and Engel. From experiments with hydrate of chloral they find (*inter alia*) that the dissociation of a substance whose two components are volatile takes place even in presence of one of the products of the dissociation, so long as the tension of this product does not exceed that of dissociation of the substance at the temperature operated with.—On the determination of glucose in the blood, by M. Cazeneuve.—Facts bearing on the history of beer yeast and alcoholic fermentation; physical and physiological action of some saline substances on normal yeast, by M. Bechamp. The action of acetate of soda is specially studied.—On the form of muscular contraction of the muscles of the crayfish, by M. Richet. Between the principal muscles, that of the tail and that of the claw, there is as considerable a difference as between smooth and striated muscles in vertebrates.—The cochineals of the young elm, a new genus, *Ritsemia pupifera*, by M. Lichtenstein.—Why one sometimes finds plants of limestone associated with those of silica, by M. Contejean.

May 5.—M. Daubrée in the chair.—The following papers were read:—On the heat of formation of cyanogen, by M. Berthelot. Cyanogen (like acetylene and bioxide of nitrogen) is a substance formed with absorption of heat. The mean number, 132·3 cal., was obtained for its heat of combustion (the equivalent (C_2N = 26 grammes); this number is somewhat less than Dulong's.—On some derivatives of durol (α-tetramethylbenzine), by MM. Friedel, Crafts, and Ador.—Experiments for determining the direction of the pressure in a slanting arch, by M. de la Gournerie.—On the transformations of the second order of hyperelliptic functions, which, applied twice successively produce duplication, by M. Borchardt.—On the crystals extracted from cast iron by ether or petroleum, by Prof. Lawrence Smith. The cast iron is treated in a finely divided state. It yields a soluble matter consisting chiefly of sulphur, and crystallising in fine needles, like the matter which the author has separated from meteoritic graphite. M. Berthelot stated he had got like crystals by treating artificial or natural sulphides with ether or alcohol, and he attributed the matter to chemical action of the sulphur on the hydrocarbonised solvent. The results inspire reserve in conclusions as to pre-existence, in meteorites, of those crystallisable hydrocarbonised matters which are capable of extraction by organic solvents.—M. Daubrée presented a memoir by M. Abich, on the production and geotechnic conditions of the naphtha region near the Caspian.—Mr. MacCormick was elected correspondent for the section of Rural Economy, in room of the late M. Chevandier de Valdrôme.—Reflex effects produced by excitation of the sensitive fibres of the pneumogastric and the superior laryngeal on the heart and vessels, by M. François-Franck. The effects are moderation of the heart's action conjointly with constriction of the vessels.—Effects of sulphide of carbon on the radicular system of the vine, by M. Boiteau. He points out certain evils connected with this mode of treatment. The sulphide destroys organic substances which are in its most concentrated atmosphere. Injections should be made 30 or 35 ctm. from the stem, and combined so that there should be two (of 10 grammes) per square metre.—Geometrical determination of umbilici of the surface of the wave, by M. Mannheim.—On the equivalence of algebraic forms, by M. Jordan.—On the calculation of perturbations, by M. De Gasparis.—On a theorem of dynamics, by M. Siacci.—On the thermal formation of siliciated hydrogen, by M. Ogier. He tried to determine the heat of combustion by means of free oxygen; whence he finds the union of $Si + H_4$ to be accompanied by a liberation of heat = + 24·8 cal., which is near the heat of formation of marsh gas (+ 22 cal.).—On the limit of separation of alcohol and water by distillation, by M. Le Bel. Ninety-seven per cent. was attained.—On a new isomer of angelic acid, by M. Duvillier.—Transformation of camphic acid into camphor, by M. De Montgolfier.—On the contractility of blood-capillaries, by M. Rouget. In all vertebrates a contractile coat of the same type, modified only in the number of its elements, envelopes the whole system of vascular blood-canals, including the heart and the capillaries. Contractility (modified only according to region) is an essential property of all the system.—On the action of salts of strychnine on gasteropod molluscs, by M. Heckel. These animals show a remarkable immunity as regards salts of strychnine. As in vertebrates, the degree of injuriousness of the poison is in inverse ratio of the animal's weight. The toxical phenomena are of the same order as in higher animals, *i.e.*, strychnine is a poison of the nervous system (tetanising).—On the *Haptophrya gigantea*, a new opaline of the intestine of anouran Batrachians in Algeria, by M. Maupas.—Artificial reproduction of native carburetted iron of Greenland, by M. Meunier.

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