THURSDAY, MARCH 1, 1877

GOVERNMENT GRANTS IN AID OF SCIENCE

THE Civil Service Estimates for this year contain three different sums proposed to be granted by the government in aid of scientific research. As the circumstances connected with these grants do not appear to be generally well understood, it may be convenient to those engaged in the study of science to have a short explanation given to them on the subject.

The oldest and best known of these grants is that of 1,000*l.* which has been given to the Royal Society for the last twenty years, for the encouragement of scientific research. The distribution of this grant is regulated by a Committee of the Council and other Fellows of the Royal Society, usually denominated the "Government Grant Committee." The manner in which it is expended is given in the published *Proceedings* of the Royal Society every year. Last year, we observe, grants of 100*l.* were sanctioned to Mr. J. A. Broun, for "investigating the effects due to the sun's rotation and magnetism;" to Mr. J. N. Lockyer, to enable him "to continue his spectroscopic researches;" to Dr. Carpenter, in aid of his work on *Comatula* (or *Antedon*, as he prefers to call it); and to Sir W. Thomson and Prof. J. Thomson for the construction of an analysing machine suitable for performing certain calculations connected with the observation of tides. Other smaller sums were assigned to Dr. Stenhouse, Mr. G. J. Romanes, Mr. W. Crookes, and Prof. W. E. Adams, in aid of various researches in which these philosophers are respectively engaged.

Last year, as we stated on a former occasion, in consequence of the report of the Royal Commission on Science, the propriety of increasing the amount of this grant was considered by the Government. It was ultimately arranged that instead of making any alteration in the mode of distributing the grant of 1,000*l.*, which seemed to have answered its purpose very satisfactorily, a second grant of 4,000*l.* should be made, to be admininistered in a different manner. Instead of being given by the Treasury direct to the Royal Society, the new grant, in order to carry out another recommendation of the Duke of Devonshire's Commission, to the effect that the scientific work and votes should be placed under one Minister, was placed in the Privy Council Estimates, and will be distributed directly by the Lord President, according to a scheme prepared by the "Government Grant" Committee of the Royal Society, together with the presidents of fifteen other learned societies, who, for this object, are *ex officio* members of this Committee.

There are now, therefore, two different grants in aid of scientific research administered by the Royal Society: that of 1,000*l.* received direct from the Treasury appropriated mainly to the providing of instruments and other assistance necessary to scientific inquiries; that of 4,000*l.* applied to the aid of scientific investigators not only by providing instruments and assistance, but by making personal allowances or grants of money to the investigators for their services. As regards the last-named fund, on the proposed distribution of which the Government Fund Committee is now occupied, we understand that the applications made for it for the present financial year (1876-77) have amounted to upwards of 14,000*l.* To three sub-committees (Physical, Chemical, and Biological) who have been for some time past engaged in investigating these applications, is assigned the pleasing task of reducing them to more moderate dimensions, and bringing them again before the whole Committee, which meets to-day, in order that they may be submitted to the Lord President of the Council for his final approval.

When it is possible to refer to the proceedings of the Committee without any breach of confidence, we shall state at length how the great question of the endowment of research has been aided, or the reverse, by the action of the Fund Committee. It is well known that there are many Fellows of the Royal Society whose positions as workers in science need not be too clearly defined, who view with mistrust the liberality of the Government. But we have the greatest confidence in the powerful Committee which has been formed, and believe that although it is possible mistakes may be made and endowments proposed which may perhaps have a different effect from that intended, that the proceedings of the Committee viewed as a whole will meet with the warmest approval of men of science, and that it will be acknowledged on all hands that an important step has been taken in the direction of increasing research in our country.

A third grant for scientific purposes, which has been made for some years by the Government, is not so generally well known amongst men of science, and as a change is to be made in its administration this year, it may be as well to give a few explanations on the subject. Commencing with the year 1871-72, as it appears from the Parliamentary return now before us, a sum of 2,000*l.* has been voted annually to the department of the Privy Council Office for "auxiliary scientific investigations." By reference to the same return, it will appear that in 1871-72 and the three succeeding financial years this sum, under the recommendation of Mr. John Simon, late Medical Officer of the Privy Council and Local Government Board, was divided pretty nearly equally between Dr. Sanderson and Dr. Thudichum, portions of the grant in each case being devoted to laboratory expenses and the payment of skilled assistants. The results of this expenditure have been various reports on such subjects as "Infective Inflammation," the "Chemical Changes in the Case of Typhus," and the "Pathology of "Sheep-pox," and other scientific investigations connected with questions of public health, which have been published as appendices to Mr. Simon's reports as Medical Officer of the Privy Council and Local Government Board. Mr. Simon having resigned his office last year, and there being no longer any medical officer attached to the Privy Council Office, the vote of 2,000*l.* has, we observe, in the Civil Service Estimates for the present year, been transferred to the Local Government Board, and will, we suppose, be administered in future by Mr. Sclater Booth, the President of the Board, under the advice of Dr. Seaton, who has succeeded Mr. Simon in his functions as principal medical officer of that department. Whether this transfer of the fund will involve any alteration in its disposal remains to be proved.

THE LIFE OF SIR WILLIAM FAIRBAIRN

The Life of Sir William Fairbairn, Bart., F.R.S., LL.D., D.C.L., &c. Partly Written by Himself. Edited and Completed by William Pole, F.R.S., Member of Council of the Institution of Civil Engineers. (London: Longmans, 1877.)

THE art of Engineering is one by which above all others the influence of science upon the civilisation of the world has been proclaimed with the loudest voice. Astronomy may deal with far more tremendous mechanical problems and may have done more for establishing the exactness of scientific research. Chemistry may have done much for the amelioration of suffering, and have given to the world vast commercial enterprises. Geology and Metallurgy have told men where to find and how to use the wealth beneath their feet; and to Physics we owe the Electric Telegraph and a thousand things besides. But Engineering, combining all of them with much that is its own, goes out to the world and makes itself heard and known by every class. Millions who never heard of the *Nautical Almanac* see the feats of navigation and the power of ocean ships. The locomotive, diving under mountains or flying over valleys leaving civilisation in its track, preaches the power of steam to people who may never hear of the dynamical nature of heat. And the splendid machinery by which the commonest things of life are made testifies to the greatness and humanising influence of that art which, above every other, directs the great powers in Nature to the use and convenience of man.

To Engineering, civil and mechanical, this country, more perhaps than any other, owes its wealth and not a little of its fame; and the British public has always delighted to honour the veterans of the profession to which its country owes so much, more especially those who by great originality of mind, broad unprejudiced common sense, sound reasoning, and indomitable perseverance, triumphing over all opposition and difficulty, and abandoning the beaten paths of their fellow-men (whenever those paths led wide of their mark), have cut out for themselves new roads and made themselves pioneers in their profession, adding to it fresh lustre, and lifting themselves thereby from a humble position of life to a great and honoured place in the estimation of their fellow-men. Of such men as Brindley, Watt, Telford, Stephenson, Rennie, Maudslay, Nasmyth, Whitworth, and Fairbairn, this country may justly be proud, for with their names are mixed up, in no small degree, its prosperity and its fame.

The story of such eventful lives cannot but be full of interest and instruction; interesting as tales of the vicissitudes of fortune, the difficulties, trials, hardships, and triumphs inseparable from the life of a "self-made" man, and instructive in the highest degree, as putting upon record the history and development of those branches of human progress which played so important a part in the drama of their lives.

The career of Sir William Fairbairn, which extended over eighty-five years, was an exceptionally eventful one, and the biography before us possesses an especial interest from the fact of its being partly written by himself, and written, too, in so pleasant and animated a style as to carry the reader with him into all the scenes of his life, and to show that he was as accomplished a writer as he was a mechanician. Indeed, he was a most prolific author, having given to the world some eighty publications, several being of the highest scientific character, and published in the *Philosophical Transactions*, as well as several large and important works upon engineering subjects.

William Fairbairn, like his friend, George Stephenson, raised himself from the humblest rank of life, being the son of a small farmer or "portioner" of Kelso, where he was born in the year 1789. When little over four years old he attended the parish school, where he learnt to read from some of the best poets and prose-writers, and in his own words, "if to these be added a course of Arithmetic as far as Practice and the Rule-of-Three, they will constitute the whole of my stock of knowledge up to my tenth year." He gives a lively description of the hard training which prevailed in Scotland at that period, and of the severity with which discipline was enforced in the Scottish schools. At the age of fifteen Fairbairn was apprenticed to a Mr. Robinson, a millwright at the Percy Main Colliery, near North Shields, and here he had a rough time of it. Surrounded by temptations of every kind, and with the lowest possible of companions to associate with, he sketched out for himself a weekly curriculum of study, in which literature, mathematics, and recreation were pretty evenly distributed. This he kept up with wonderful constancy, and in a short time was able to turn the tables upon those who ridiculed him, by proving the superiority which learning gave him.

It was also at this time that he made the acquaintance of George Stephenson, who had then charge of an engine at Willington Ballast Hill, only a mile or two from Percy Main Colliery. The two young men, who were nearly of the same age, and were both earnest in their love for mechanics, here formed a friendship which lasted through life. It is on record that in the summer evenings Fairbairn was accustomed to go over and see his friend, and would frequently attend to the Ballast Hill engine for a few hours, in order to enable Stephenson to take a two or three hours' turn at heaving ballast out of the collier vessels, by which he earned a small addition to his regular wages: and he often, in after life, alluded with pride and satisfaction to his early intimacy and close friendship with the great founder of the railway system.

At the age of twenty-one, Fairbairn, wishing to see more of the world, and being at this time of a roving disposition, went in search of other employment, which he obtained first at Newcastle, then at Bedlington. From here he went to London in the winter of 1811 with *2l. 7s. 6d.* in his pocket, and immediately set out to look for work, which he failed to get, through the tyranny of the Millwright's Trades-union Society. For some time after this William Fairbairn was more or less a "rolling stone," travelling about the country picking up odd repairing jobs, and seldom remaining in one place for long.

We find him in Bath, Bristol, South Wales, Dublin, Liverpool, and Manchester, which he entered in the winter of 1813, when he was in his twenty-fourth year, and obtained employment with Mr. Adam Parkinson, with whom he remained two years: he was at this time earning thirty shillings per week, and this enabled him to fulfil in 1816 his engagement of marriage, which had

existed for five years. From this time he determined no longer to remain the servant of another, but by a bold effort to take an independent position.

The result of this determination was that he entered into a partnership with an old shopmate of the name of Lillie, and in a miserable shed which they hired for twelve shillings a week they set up a lathe which had to be turned by hand, and thus began a business which but a few years afterwards had a world-wide reputation.

The first order that came to the new firm was a somewhat important one—the taking down and renewal of the whole of the shafting in an extensive cotton-mill belonging to Messrs. Adam and George Murray. In carrying out this work, originality of mind and sound reasoning powers which Fairbairn brought to bear upon everything he undertook, came to his aid; he saw that the old system of mill-gearing was wrong in principle, that quick shafts and small drums would do the work with a great saving of power and space, and thus he revolutionised the whole system of mill-work, and the firm of Fairbairn and Lillie became the leading millwrights of the district. Orders poured in upon them from all sides, and they removed from the shed to a larger building, to which was afterwards added a cellar.

"I was," Mr. Fairbairn says, "designer, draughtsman, and book-keeper, and in order to meet all the requirements of the concern and keep Mr. Lillie's department in the shop constantly going, I had to rise with the sun in the summer and some hours before it in winter, in order to make the entries and post the books before breakfast. In the remainder of the day I had either to draw out the work or to ride fifteen or sixteen miles on a hired hack to consult with proprietors, take dimensions, and arrange the principle upon which the work was to be constructed."

Four or five years passed in this manner, and though the firm was always short of money it was daily increasing in prosperity; orders came in far beyond what they could execute, they kept adding to their stock of tools, and ultimately purchased a second-hand steam-engine by Boulton and Watt, bought a piece of ground, and erected a larger and more convenient workshop.

In the year 1824 Mr. Fairbairn designed and carried out the great Catrine Bank water-wheels in Ayrshire, in which he introduced so many improvements upon the old system of water power, that his firm for many years stood almost alone for such work, and received orders from all parts of the Continent until the principle which he had introduced became generally known. Thus the business increased, and in the year 1830 their stock-book showed a balance of nearly 40,000*l.*, and left them sufficient funds to increase their works, so as to be capable of employing 300 men. During this year William Fairbairn was elected a member of the Institution of Civil Engineers under the presidency of Thomas Telford.

The following two years were occupied in his celebrated experiments for the investigation of the properties of iron boats and the application of steam power to canal navigation, and it was in connection with this investigation that he made his first essay in engineering literature, "Remarks on Canal Navigation," which was published by Longmans in 1831.

These experiments led to the construction by his firm and from his designs, of the *Lord Dundas*, a small paddle-wheel vessel, built entirely of iron, and driven by a steam-engine of 0-horse-power. This was the first iron steam-vessel, and the results of its trials were looked for with considerable excitement. Mr. Fairbairn gives a most interesting account of this little vessel and of her sea trip from Liverpool to Glasgow, a voyage not unattended with danger through the error of the compass due to the magnetic influence of the iron, of which the vessel was constructed; and no greater instance of the clearness of perception of this young engineer can be given than the fact that he not only detected at once the cause of the aberration of the vessel's course, but also corrected the compass error, compensating the ship's attraction by pieces of iron placed in the vicinity of the needle.

In the year 1832 a dissolution of partnership took place, and the Manchester works came into the sole possession of Mr. Fairbairn. Soon after this the subject of iron shipbuilding began to attract public attention, and he had many orders for vessels between 100 and 250 tons burden, which had to be built in Manchester, taken to pieces, and rebuilt at a seaport. To avoid this obvious inconvenience, and believing there was large business to be done in this branch of Engineering, Mr. Fairbairn bought a plot of land on the Thames, at Millwall, where, besides his Manchester business, he carried on for thirteen years large ship-building operations, having during that time built upwards of a hundred vessels, including several for the Royal Navy; but, with the exception of the first two years, the concern was a losing one, and it was ultimately wound up and sold at great loss. After passing through several hands it came into the possession of Mr. Scott Russell, and it was on this spot that the *Great Eastern* was built.

It was at these works that Fairbairn's celebrated experimental researches, in connection with Mr. Eaton Hodgkinson, upon the strength of cast-iron were carried on, and it was here that he conducted the experiments previous to the designing of the Britannia and Conway tubular bridges, and which led to his invention of the rectangular self-supporting tube, having cellular top and bottom sides. This is the essential principle of construction in those triumphant feats of engineering skill, and in connection with which his share of the merit is too often passed over.

This invention, for which a patent was taken out in his name with the concurrence of Mr. Stephenson, led to his being invited by the Chevalier Bunsen, at that time the Prussian Minister, to visit Berlin in order to confer with the authorities upon the erection at Cologne of a tubular bridge for the purpose of carrying the railway across the Rhine. This bridge, as far as he was concerned, was never built, but it led to a warm friendship between himself and Alexander von Humboldt, as well as with Bunsen, and the chapter relating to this connection will be of the greatest interest to the readers of this journal, containing, as it does, letters of Humboldt and Bunsen, and some very interesting letters of Sir William Fairbairn. Describing, in a letter to Dr. Robinson, of Armagh Observatory, his dining at the table of the King of Prussia where he made the acquaintance of Humboldt, he gives his impression of the great philosopher as follows:—

"I must, however, inform you that I was seated with feelings of pride and gratification beside a greater man than the King, and enjoyed the benefit of a conversation

similar to that I had the pleasure to listen to on the occasion of a recent visit to a highly valued friend of kindred mind and pursuits. I cannot express to you how much I valued the society of this amiable and distinguished man. At eighty years of age he possesses the mental energies of a man of forty, and retains what appears to me to be the desideratum of advancing years, a mind susceptible of impressions, with a power of discernment and retention which can only be looked for in the maturity of life. Such, however, is the mind of Humboldt, perfectly alive to every improvement and every development in the advancement of his favourite studies."

It is pleasant to compare this letter with one written by Humboldt to Bunsen, as showing that this cordial feeling was mutual between them; in it Baron Humboldt says:—

"I cannot be grateful enough to you for having made us acquainted with a man possessing so much knowledge, so highly esteemed by all, so amiable, and so modest;" and he adds: "The king was enchanted by the demeanour of the great man, and Mr. Fairbairn did not like less the frank and hearty demeanour of the King."

An interesting chapter of this interesting book is that devoted to the researches for the experimental determination of the influence of pressure in the process of solidification as bearing upon the solution of the question of the solidity or fluidity of the centre of the earth, and the thickness of the earth's crust. This inquiry was instigated by the late Mr. Hopkins, of Cambridge, and was carried on at Mr. Fairbairn's Works at Manchester, in conjunction with Mr. Joule and Prof. (now Sir William) Thomson. As the experiments involved the submitting of various substances to enormous pressures—sometimes as great as 6,000 pounds upon the square inch—the mechanical fertility of Mr. Fairbairn's mind was of very great value to the investigation. The results of these experiments pointed to the conclusion that the least thickness that can be assigned to the solid envelope of the earth must be considerably greater than geologists have imagined it to be. This investigation was carried on three-and-twenty years ago, and it is interesting to notice that its result corroborates in a remarkable degree the conclusion which Sir William Thomson enunciated at the recent meeting of the British Association at Glasgow.

As a scientific man Sir William Fairbairn held a high position, he had an essentially analytical mind, seeing, by an intuitive reasoning characteristic of him, into the principles of things, separating essential from accidental results, and thereby directing his experiments to the best advantage. In 1850 he became a Fellow of the Royal Society, and two years after a Corresponding Member of the Institute of France. In 1861 he was the president of the Manchester Literary and Philosophical Society, which office he had held for five years. In 1860 he received one of the Royal medals of the Royal Society for his papers in the *Philosophical Transactions*, and the following year he held the office of President of the British Association, which met at Manchester. In consideration of this and of his services to engineering science he was offered the dignity of knighthood, which he refused. Eight years after, and when in the eightieth year of his age, he accepted a baronetcy which was offered him by Mr. Gladstone's Government. He survived this honour five years.

A more useful and eventful life than that of Sir William Fairbairn rarely falls to the lot of a biographer to record. The work before us shows, however, that it has fallen into good hands. Dr. Pole is himself an engineer and a man of science: he was associated with Sir William Fairbairn in many of his works, and he possessed exceptional qualifications for telling the story of such a life. The interest—whether personal, historical, or scientific—is maintained throughout the book, and as an autobiography of great literary merit we would recommend it to our readers.

C. W. C.

GROTH'S "CRYSTALLOGRAPHY"

Physikalische Krystallographie und Einleitung in die krystallographische Kenntniss der wichtigeren Substanzen. Von P. Groth. Mit 557 Holzschnitten im Text, einer Buntdruck, und 2 lithographirten Tafeln. (Leipzig: Wilhelm Engelmann, 1876.)

PROF. GROTH has written a good book on a subject for which, if it attracts but few students in England, German universities will supply readers. It is a good book, as being written by a man whose work puts him in an authoritative position for writing it, while to anyone who is master of the small mathematical experience needed it is eminently readable, is to the point, and not too voluminous. It is moreover copiously and well illustrated. Of course, even as an Arabic chronicler of the events of his time, invariably commences his history with the origin of things, and the early traditions of mankind, so a German professor who writes on crystallographic optics, of necessity devotes a good many pages to a sketch of the fundamental laws of optics and the general principles of the undulatory theory. Our author, however, while doing so never loses sight of his purpose, and a few pages so occupied are probably intended to fill a void in the training of some of those for whom the book is intended.

Indeed for the student who wishes to obtain only so much knowledge of the principles of physical optics as is requisite for following the methods of the crystallographer, it would be difficult to find a more compendious and useful statement and illustration of those principles than in Prof. Groth's book; the exposition of them being so completely cleared of difficult mathematical language that the student might be led on to the possession of a fair insight into the optical characters of a crystal without any idea of the profound and splendid series of mathematical achievements by which the theory of light has been elaborated.

Prof. Groth has dealt in a similar if less complete way with the thermic properties of crystals. One might perhaps have expected a fuller treatment of the subjects of cohesion and cleavage, of the relations of crystals to magnetism, and of the results and the best methods of experimenting on pyroelectric crystals, in a treatise on the physical aspects of crystallography.

What is perhaps the best part of Prof. Groth's work is the description of the instruments used by the crystallographer, such as the "polarisation-instrument" as he calls that necessary companion which has been hitherto known, under its very usual form, as a Nörremberg, or as a polariscope, or as a polarising microscope. This instrument has been reconstructed by our author in an

improved form, which gives a field nearly if not quite as large as that of the instrument of Nörremberg and somewhat better definition near the edges; and, by the use of a scale engraved on a glass plate, approximate measurements of the angle of the optic axes of a crystal can be obtained when the apparent angle is not too great for the optic axes, or rather the "eyes" of the axes to be seen in the field of the instrument.

The application of the principle of von Kobell's stauroscope, enhanced in its sensitiveness by the use of the ingenious doubled calcite plate of Brezina, is also valuable for ensuring precision in determining the directions of the principal sections of a crystal, and is for example far more commodious than Descloizeaux's method of dividing a plate of an oblique crystal, cut parallel to the plane of symmetry, into two, and turning them after the manner of an artificial twin.

The crystallographic portion of Prof. Groth's work is good, especially so from the point of view of the student in the German universities, where the honoured name of Naumann still holds crystallographers by the spell of a notation which has the advantage of looking very simple, while in reality it is complex and incomplete, and for purposes of calculation, and indeed for other than a very superficial crystallographic representation of crystal forms —not of crystal faces—has next to no value.

Of course, Prof. Groth is too sound and excellent a crystallographer not to feel and to acknowledge as he does in his preface, the great superiority of the method of Prof. Miller for all the purposes which give crystallography its character as a science; and accordingly he introduces his readers to the system of Miller, co-ordinating the two methods of notation in his descriptions of crystalline forms.

Indeed, when he touches on the fundamental principles of crystallography in his section on the doctrine of zones, he discards at once the notation of his illustrious countryman, and handles the subject entirely in the language and method of Miller; a language and method which in fact are the result of an elegant development of the original principle of Weiss, and were first independently employed by the famous German mathematician, Grassmann. In point of fact every crystallographer now uses the Millerian formulæ, and actually while using the notation of Naumann, prefers to translate it into the simpler symbols of Miller in order to deduce the determinants rather than employ the earlier modes of calculation.

Again, what crystallographer who has had to convert the notation of Naumann for the rhombohedral into that for the hexagonal system, but knows the complexity of the process, and must recognise the superficial character of that notation? Moreover, for a distinctive representation of hemi-symmetrical or tetarto-symmetrical forms in language or writing that carries a scientific meaning, the notation of Naumann is powerless.

But Prof. Groth is writing for a German public, and he has to write a book that will be read. It is to be hoped that his work will be widely read, so widely as that his intelligent countrymen may be prepared, when it reaches a second or at furthest a third edition, to accept the change to the Anglo-German notation and methods which Weiss, Neumann, Grassmann, Whewell, and Miller (five of the greatest names among European crystallographers), have elaborated.

There remains, however, a word to be said upon the examples selected by Prof. Groth to illustrate this part of his treatise. They are as interesting to the crystallographer as they are excellent from the point of view of illustrations; for the publication of several of them in this form serves to bring together valuable illustrations of the different kinds of merosymmetry, of which some are new, while others have to be sought for only in the memoirs in which they appeared.

It may have been the result of a practical estimate of the smallness of the number of Englishmen who would have been interested in seeing them, that prevented Herr Fuess, the optical-instrument-maker of Berlin, from sending to the Loan Exhibition a set of the instruments in the improvement of which he has been so largely guided by Prof. Groth. It was, however, a short-sighted view, for the students of this subject are increasing; the physical laboratories of Oxford and Cambridge, and some London teachers of physics, are, for instance, turning out students quite competent to handle and to appreciate such implements of research; and for all such students the instruments of Soleil and the other French makers represented in the Loan Collection naturally have the greater attraction due to proximity and to their having been for several months where they could be seen and handled by English teachers and their students.

N. S. M.

OUR BOOK SHELF

La Digestion Végétale, Note sur le Rôle des Ferments dans la Nutrition des Plantes. Par E. Morren. (Gand, 1876.)

THIS paper is brought forward by Prof. Morren as a supplement to his observations on carnivorous plants. Its main point is the statement that digestion is not a function exclusively of those plants termed "carnivorous," but is a process common to all living beings, vegetable as well as animal. Animal digestion is, he states, according to the most approved view, a process of fermentation consisting essentially in a transformation of colloids into crystalloids, this change being a necessary preliminary to absorption. In the same manner all plants digest; and the process is precisely analogous to that of animals, and is again essential before assimilation is possible. The ordinary vegetable ferment for the conversion of starch into glucose is diastase, which has been detected in barley; it occurs also in the tubers of the potato, near the "eyes." For the fermentation or digestion of nitrogenous substances, albuminoids, a different ferment is required, and this we have in pepsine, which has been detected by several observers in the viscid secretion of *Nepenthes*, *Drosera*, and other insectivorous plants. According to Masters, it occurs also in the nectaries of *Helleborus;* and a similar substance has long been known in the latex of *Carica Papaya*. Vegetable digestion is therefore as widely diffused and as various a phenomenon as animal digestion, and consists in the transformation of the raw insoluble food material into soluble crystalloids capable of assimilation. It takes place chiefly in the "reservoirs of reserve-material"—seeds, underground stems, roots, the bark, the pith. The nutrition of plants is made up of three successive processes:—elaboration, digestion, assimilation. The first consists in the production, out of its elements, of a carbo-hydrate, and can take place only under the influence of light. Digestion consists essentially in hydration—as in the conversion of starch into glucose—and is associated with an evolution

of carbonic acid. It is accompanied by a molecular change which renders the resulting product soluble and diffusible. Assimilation is simply the absorption by the living tissue of the substances thus prepared, one of the chief processes which accompanies it being the reversion, by loss of water, of the glucose to the condition of cellulose, a substance isomeric but not isomorphic with starch. Intussusception, therefore, is a process which can only succeed digestion. No essential difference can, in fact, be maintained between the manner in which animals and plants digest their food. A. W. B.

LETTERS TO THE EDITOR

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts. No notice is taken of anonymous communications.*]

Hygroscopic Seeds

I HAVE lately received an interesting letter from Fritz Müller, in St. Catherina, Brazil, on the subject of hygroscopic seeds. He tells me that in the highlands of the Uruguay he has succeeded in discovering more than a dozen grasses, as well as a species of geranium, whose awns are capable of hygroscopic torsion. He has been so kind as to send me specimens of the grass-seeds, and many of them appear to be as beautifully adapted as those of Stipa, Avena, &c., for penetrating the ground in the manner which I have elsewhere described.[1] The most curious among the specimens received are the seeds belonging to the genus Aristida. In one of these the awn is longitudinally divided into three fine tails, six or eight inches in length, each of which twists on its own axis when the seed is dried. These tails project in three directions, and more or less at right angles to the axis of the seed, and Fritz Müller states that they serve to hold it in an upright position with its lower end resting on the ground. The seed is pointed and barbed in the usual manner, and when it is made to rotate by the twisting of the awns, it evidently forms a most effectual boring-instrument, for Fritz Müller found many seeds which had penetrated the hard soil in which the parent plant was growing. Another species of Aristida is interesting to me, because it illustrates the explanation which I gave of the torsion of the awn of Stipa, namely, that each individual cell of which the awn is composed is capable of torsion, and their combined action results in the twisting of the whole awn. Now in this species of Aristida, each of the three tails into which the awn is divided is capable of torsion on its own axis, and as the seed dries they twist up into a perfect three-stranded rope, just as the component cells combine to produce the rope-like twist of the Stipa awn. And as the tails wind together and form the strands, the seed is made to rotate and thus bury itself in the ground.

Down, Beckenham, February 19 FRANCIS DARWIN

Mind and Matter

BUT for illness I would have made an earlier reply to Mr. Duncan's courteously-expressed objections (NATURE, vol. xv., p. 295) to my analysis (NATURE, vol. xv., p. 217) of his very ingenious "solution" (NATURE, vol. xv., p. 78). A general "mistake," and an "essential omission," are the charges against me. The mistake is in "regarding what was intended to solve a problem as intended to prove an alleged fact." "The alleged fact," he adds, "that consciousness depends on nervous organisation, I assumed to be a fact, and undertook to indicate *how* the dependence might be conceived, or regarded, to exist." He says that I clearly understood this "at starting." Where now is it that I "fell into the error?" His first step towards "clearing away difficulties in the way of our *conceiving* the relation of consciousness to matter," is to allege this fact: "It is no more difficult to conceive of matter being subjective than of spirit being subjective." This is a dogmatic statement about our powers of conceiving; no hint of help as to *how* we may conceive. We ordinarily conceive of "spirit"—the "ego," the "subject"—as susceptible to consciousness, or "subjective," because we (the ego) feel we are conscious; but is it "as easy" to conceive of a stone as susceptible to consciousness, *i.e.* subjective? To say *it is*, I called a *petitio principii*, because it assumes that conceivability which has to be established. I used the word "probability" as involving conceivability; for can we intelligibly assume a probability without a conception of what that probability is? But Mr. Duncan contends that his position is "conceivable as a hypothesis, true or false." Unquestionably we may conceive some one stating any hypothesis—a stone feels, fire freezes—but to conceive one doing this is not to have a concept of any part of the operation as hypothesised, however we may attach a meaning to the terms as such. Again, if any hypothesis, true or false, is already conceivable, this fact cannot favour Mr. Duncan.

So far I have not been led "to mistake allegations of the conceivability of a notion for assumptions or intended proofs that the notion is true." To the next position, "How energy is related to matter, is no less mysterious than how subjectivity may be a property of matter," my objection was twofold: first, to the illogical form; second, to the argument itself. Mr. Duncan replies, "The parity of mystery was not intended to establish parity of probability as to facts, but merely parity of conceivability." Now what *is conceivable* in the known case? The *fact* of energy being related to matter. Next, what here is mysterious or *inconceivable?*—the *manner how* these are related. Finally, what is the parallel to establish? Mr. Duncan answers, "Not the parity of probability as to facts, but merely parity of conceivability." But the conceivability of *how* energy is related to matter equals zero, therefore, by parity of reasoning, the conceivability of how subjectivity is related to matter equals zero. I commented, therefore, on all that this argument supplied—a bare shadow of *probability*. My next objection to the position, "Energy may be divided, why not subjectivity?" is strictly categorical, and no flaw has been found in it, nor, intrinsically, in any of my objections, which have now been shown to apply to "conceivability." Of the omission, Mr. Duncan says:—"The essential part of my solution which indicated roughly the *modus* of the connection between matter and consciousness, and which dealt with the great difficulty of the question, How to account for the two aspects of matter, the conscious and the unconscious? has not been touched by Mr. Tupper." Because all this was based on the untenable ground that "subjectivity may be divided," I closed my analysis here; but will conclude with a few remarks on the ingenious and original parallels drawn by Mr. Duncan.

"As energy potential is rest, so subjectivity potential is unconsciousness. As kinetic energy is motion, so active subjectivity is consciousness." Now energy, both to the materialist and his opponent, is a hypothesis, not a phenomenon; and it is not legitimate to support one hypothesis by another.

Again, if subjectivity is defined "susceptibility to consciousness," some sub-definition of "susceptibility" is needed; for if non-innervated matter, as Mr. Duncan admits, is never conscious, then matter *in this form being non-susceptible to consciousness*, is by the definition non-subjective: a conclusion opposed to Mr. Duncan's "all matter is subjective or susceptible to consciousness," his qualification, that non-innervated matter is only "potentially subjective" not availing unless this term mean non-subjective, and leave us with the above contradiction. The expression "all forms of matter may, by innervation, be made susceptible," &c., would indeed carry the conclusion "all matter may be made subjective," but then subjectivity would be an accident, not a property of matter as defined by Mr. Duncan. Lastly, to the phenomenalist who would investigate, and not create, nature, matter, or a fancied common substance for the support of all phenomena, is perhaps the most unwarranted of all assumptions. J. L. TUPPER

Atmospheric Currents

MR. CLEMENT LEY thinks (see his letter in NATURE, vol. xv p. 333) that if the earth's atmosphere contained no watery vapour, the great currents of atmospheric circulation would be quite unlike what they are. I think, on the contrary, it is as certain as the established truths of physical astronomy, that if there were no watery vapour the great currents, though not the storms and other temporary disturbances, would be nearly what they actually are.

All winds belonging to the great currents, though not local winds, form part of a system of circulation between the equatorial and the polar regions, which is caused by the difference of those regions in temperature. Equatorial air is constantly flowing towards the poles, and polar air towards the equator; the equatorial air brings the greater rotatory velocity of the equatorial

[1] *Trans. Linn. Soc.*, vol. i., part 3, p. 149, 1876.

regions into the higher latitudes, and the polar air brings the less rotatory velocity of the polar regions into the lower latitudes. The latter constitute the trade-winds, which move more slowly than the earth's rotation, and consequently appear as an atmospheric current from the east; the former constitute the "counter-trades," which move more rapidly than the earth's rotation, and appear as an atmospheric current from the west.

The centrifugal force of the "counter-trades," as they circle round the poles, is the cause of the polar depression of the barometer.

The law of reaction makes it impossible for the earth's rotation to be either accelerated or retarded by the winds, and consequently the entire "torsional force" exerted by the winds on the earth must, at any given time, be equal in the easterly and westerly directions.

I have now described in outline what theory shows that the circulation of the atmosphere would be in the absence of watery vapour and in the presence of the sun's heat and the earth's rotation; and observation shows that such is the actual circulation on the large scale, and not taking account of local disturbances.

JOSEPH JOHN MURPHY

Old Forge, Dunmurry, Co. Antrim, February 23

Halo round Shadow

IT is not uncommon for an observer, when looking at his own shadow on rough ground or turbid water, to see its head surrounded by a halo, of which the brightest part is in contact with the shadow.

This phenomenon has often elicited notice, but as far as I am aware has not before now been explained, nor do those who have mentioned it seem to have observed that its appearance depended on the nature of the surface receiving the shadow.

The conditions necessary for the production of these halos are—

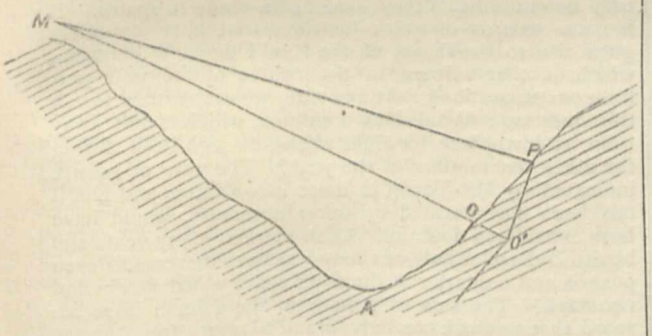
1. That the screen, as whatever the shadow is cast on may be called, should not be a continuous surface, but a number of small surfaces with intervals between them, each of these small surfaces of course casting its own shadow on whatever happens to be behind it.

2. That the shadow should be at a considerable distance from the observer.

3. That the light should not fall very obliquely on the screen.

The first of these conditions only is essential, but the fulfilment of the last two makes the phenomenon more marked.

Rough grass forms a good screen, especially if, as in the diagram, conditions 2 and 3 are fulfilled by the shadow being



cast on one side of a valley, while the observer is standing on the other.

In the case of the shadow on turbid water, it must be remembered that it is not the surface of the water which forms the screen, but the particles suspended in it.

The general explanation of these halos is this—

From the observer's point of view the screen in the immediate neighbourhood of the shadow of the head is seen in nearly the same direction as it would be from the source of light. In this direction, therefore, each of the small surfaces of which the screen is made up will hide its own shadow, but this will be true of no other direction; and the effect on the whole will be that the screen will appear brighter close to the shadow of the observer's head than elsewhere.

To examine this rather more in detail, let M A O be a section of the ground passing through the observer at M and his shadow at O. Let

$$O'P = r \quad O'MP = i$$
$$O'PM = \text{a right angle.}$$

Let w and w' be the projections on $o'P$ of the average breadth of the sections of the small surfaces made by the plane M A o, and the average distance between them respectively, and let h be the average distance of each of the small surfaces from its own shadow.

Then the amount of light received from any space $r\,d\theta$ $(w + w')$ may, *cæteris paribus*, be taken without any great error as a measure of the brightness of the zone whose mean radius is r, and whose breadth is $w + w'$ ($d\theta$ being a small rotation of r about o' M), and this will be proportional to $w + w' - h \sin. i$, The decrease in brightness is proportional to h and sin. i, and will reach a maximum when $h \sin. i = w$, if $w < w'$, or $= w'$ if $w' < w$.

Outside the circle defined by this value of i the brightness will be sensibly constant, because the quantities of which w, w' and h are the average values have all manner of actual values, even in a very small space.

These expressions are only approximate, but they serve, as well as the longer exact formulæ, to show the general laws of the phenomenon.

ARNULPH MALLOCH

Meteor

THIS evening, at close upon twenty minutes past six, as I was walking in my garden towards the almost full moon (which was very bright), I observed a brilliant meteor pass from right to left over, and very near, the moon's disc. It was visible for a distance of about twice her diameter. From the amount of daylight, and the extreme brightness of the moon, I judge this meteor to be worth recording.

C. M. INGLEBY

Valentines, Ilford, February 26

Tape-worm of Rabbits

So far as I am aware the only evidence in favour of the view that *Bothriocephali* present no hydatid stage is that which has been furnished by the researches of Knoch. To me it has always seemed that this evidence is insufficient fully to overcome the analogical probability that tape-worms of this genus resemble tape-worms of other genera in passing through a hydatid stage—and this notwithstanding the occurrence of a ciliated embryo. However, in my previous letter I ought no doubt to have alluded to the researches of Knoch, and should certainly have done so had my object in writing been other than it was, *i.e.*, merely to ascertain whether anyone had as yet taken the trouble to trace the life-history of the rabbit's tape-worm.

February 20

GEORGE J. ROMANES

A PROBLEM IN THE NATURAL HISTORY OF THE SALMON.

MR. FRANK BUCKLAND, in giving evidence before the Parliamentary Committee, which during last session of Parliament inquired into the condition of our oyster fisheries, stated that "a salmon (? *Salmo salar*) does not breed every year, but every three years!" On being asked by a member of the Committee if he had any proof of his averment, Mr. Buckland stated that, "he had a great idea of it," but was deficient in proof. Before examining this alleged fact in the life of the salmon, advanced by Mr. Buckland, it is proper that we should state briefly what induced him to make known his idea.

While illustrating the theory of oyster spatting, and telling the Commissioners that all the individual oysters on a *scalp* would not be found exuding their young at the same time, however favourable for spatting the period might be, Mr. Buckland also enunciated his opinion as to the periods at which salmon spawn. That gentleman holds that only one of every six oysters on a *scalp* will be found in a procreant state during the same season; and, by way of clenching his illustration, he said, "you never get salmon always breeding the same year, they take time to recover themselves, and so forth." This latter state-

ment is rather obscure ; but the interpretation undoubtedly is, that the same salmon does not breed every season. It would be instructive if Mr. Buckland were to state his ideas on this feature of the natural history of *Salmo salar* at greater length, giving at the same time a *précis* of the data on which he has formed his opinion ; because the views hitherto entertained of the spawning of salmon have been mostly contrary to those promulgated by Mr. Buckland, the prevailing idea being that salmon spawn annually. Some persons, indeed, promulgated a theory of the salmon being able to spawn twice in the same year, doubtless founded on the fact of individuals having been known to go to, and return from, the sea within a few months. There is not, however, any exact proof of these facts. There are, also, one or two gentlemen of opinion that the fish in question only spawns every two years ; but the opinion hitherto has been very general that salmon deposit their ova annually.

It is remarkable how ignorant we still are of the most important phases of salmon life, notwithstanding the active investigation of the last twenty years ; and it is still more remarkable that some of the best informed salmon anglers, intelligent students of the natural history of the *Salar* group of fishes, should hold diametrically opposite opinions, both on this and other important points of salmon life. One gentleman, whose works on angling have a wide reputation, and whose knowledge of fish-life is extensive, tells us he has no doubt the same salmon spawns every year, which, he further says, "is the generally accepted opinion on our border rivers by anglers and fishermen of the professional caste." The same gentleman informs us that the late Mr. Robert Buist, superintendent of the River Tay Salmon Fisheries, was induced by experience to arrive at a similar conclusion. Mr. Buist, who took great interest in the Stormontfield salmon nursery, was usually present every season at the capture of the gravid fish, from which the required supply of ova to fill the breeding boxes was obtained. On one of these occasions a fine grilse was captured, in good condition for being artificially spawned ; and, after being deprived of her ova, the fish was carefully marked, and restored to the river from whence she had been taken. "On the following year, at the same spot, the *same fish*, but now grown into a salmon, was retaken, full of ova, and again stripped, in order to aid in stocking the breeding boxes at Stormontfield!" This incident Mr. Buist held to be decisive of two points in the natural history of the salmon ; first, that a grilse becomes a salmon, and is not a distinct member of the *Salar* family, a point in salmon life which was at one time hotly discussed ; and, second, that the same salmon spawn every year. Another gentleman, Mr. Brown, who at one time gave his personal aid in the salmon breeding experiments carried on at Stormontfield, relates, in his notice of the proceedings, that "one year we had a very fine male fish of 24 lbs., which we marked with a wire, and *two years* afterwards we spawned him from the same ford a few pounds heavier." This same fish *may* have visited the spawning ground also in the preceding year without being recaptured for spawning purposes.

Our angling authority says further, in his communication : "I have had many opportunities of examining spent and half-spent females—those in which what is vulgarly termed the *waim* was exhausted, a few particles of ova remaining, and those taken by me or others in a spawning state ; and I invariably found new formations of ova, in the shape of two lobes, corresponding to what are found in the spring run or clean salmon, and often measuring two inches in length, according to the size of the female *kelt*, or half-spawned *baggit*. This formation cannot be taken otherwise than as an index of what was to happen after the migration seawards had been accomplished, and the term of the salmon's stay in the salt water had expired—a term which may extend to six or eight months, but has been ascertained in well-ordered rivers not to exceed that period."

None of the great naturalists, or fishers, who write on the natural history of fish—Jardine, Yarrell, or Couch—have thrown any light upon this phase of the life of the salmon. We search their works in vain to obtain information on this interesting point. The late Mr. Russel, in his book, "The Salmon," speaking at one place of the mysterious clean run fish of the early springtime, thinks "they must have passed the autumn or earlier winter in the sea ; then they must have passed the winter without breeding, and thus we have the discouraging fact or hypothesis that the salmon is a fish which does not breed every year."

We have the authority of a gentleman residing in the north of Scotland, who is well versed in the economy of our salmon rivers, for stating that the salmon only spawns every two years. He says : "I have marked hundreds of *kelts* in the months of February, March, and April, returning downwards to the sea ; I have marked them with different marks every season, so that there could be no mistake, and I have never seen one single instance of one being marked in spring return to spawn the autumn of the same year ; but I have seen hundreds with the individual mark return next spring good, clean, fine full fish. I believe that all salmon spawn only once in two years till they get too old, when they become barren ; but still they frequent the fresh water, I suppose from habit, although there is no sign of roe or milt, and I have seen and taken them off the *redds* along with fish which were in the act of depositing their spawn."

It would be tedious to run through the facts of the numerous controversies which have arisen as to the rate at which salmon grow. The experiment of marking large numbers of these fish has been often resorted to, and at different places. Mr. Young of Invershin, in his day a well-known authority on the natural history of the salmon, tells us that *spawned* grilses of four pounds weight were repeatedly marked ; and after their journey to the sea it was found that these grilses had become beautiful salmon, varying from nine to fourteen pounds weight, "the majority" returning in about eight weeks. It is much to be regretted that Mr. Young was not more explicit in his statements, because it would have been most interesting to know when these fish returned, after an absence of only two months, if they were again ready to spawn. It is these records of quick journeys that have doubtless given rise to the theory of the Rev. Dugald Williamson, which is that salmon in the course of the year perform two migrations. At any rate, we are entitled to ask this question : What does a salmon, which is only away from its birthplace for eight weeks, do with itself during the other ten months of the year? The rate of growth indicated by Mr. Young is most astonishing, and had it not been corroborated by other observers, would have been considered doubtful. A fish marked many years ago by the Duke of Athole was found to have increased eleven pounds and a quarter in the short space of five weeks and two days! The rate of growth of the salmon is so assured, that smolts have been found to return from the sea as grilse in the same season during which they left for the salt water ; but, curiously enough, none of the observers took note of what we now consider the only unsolved problem in connection with the growth of the salmon, namely, whether the *same* fish spawns annually, once in two years, or once in three years. Probably Mr. Buckland will make some additional statement on the subject. A Tay salmon fishery proprietor, whom we have consulted as to this problem in the life of the fish, will not, with all his experience, which has been very varied, and has extended over many years, venture to give an opinion, and "thinks that the question is almost beyond the reach of positive proof." It is therefore incumbent on her Majesty's Inspector of Salmon Fisheries to prove his case.

THE SOUTH-AFRICAN MUSEUM

SINCE we last gave a notice of this institution we have learned, with much pleasure, that the Cape Government has made liberal provision for its more efficient administration and maintenance. There is none of the more important British Colonies which has of late made more rapid progress than the Cape in material prosperity, and it is most gratifying to find that the Molteno administration (the first ministry organised under the Parliamentary System of Government initiated in 1872) has not been oblivious of the claims of science during its four years' tenure of office. In the estimates for the financial year 1876-77, as passed by the Colonial Legislature, we find provision made for Botanical Gardens to the extent of 2,900*l.*; for Public Libraries, 2,600*l.*; for Museums, 1,300*l.*; while such items as "Geological Researches, 1,500*l.*;" "In aid of publishing Dr. Bleek's Bushman Researches, 200*l.*;" and "Meteorological Commission, 250*l.*," sufficiently prove that the duty of endowing research is practically recognised by the Cape authorities. The present able Governor, Sir Henry Barkley, F.R.S., is as well and widely known for his attachment to scientific pursuits as for his distinction in Colonial administration, and we think we cannot err in tracing to his judicious influence much of the enlightened action of his responsible advisers in their recommendations to the Parliament.

The South-African Museum is located in Cape Town, and is the public museum of the Colony. It was instituted in 1855 under the auspices of Sir George Grey, a governor distinguished for his energy and success in initiating measures for awakening and developing the intellectual life of the Colony. Many years before there had existed a South-African Museum in Cape Town, consisting of the combined collections formed by the Expedition for Exploring the Interior, under the superintendence of the celebrated zoologist, Sir Andrew Smith, and by M. Verreaux; but this museum was devoid of means for permanent maintenance, and after languishing for a while came to an untimely end for want of public support. Many of its finest specimens, however—and notably those of the magnificent larger mammals characteristic of the region which constituted its chief ornament—were fortunately secured for the British Museum, and still form an imposing feature of the national collection. The new, or present institution, was started by public subscription aided by an annual grant from the Government of 300*l.* Two trustees were appointed by the Governor, and a third elected annually by the subscribers; but in 1857 the collections already brought together were of sufficient importance to induce the passing of an "Act to Incorporate the South-African Museum," under which all the three trustees were to be appointed by the Governor, and to be vested with full powers for the entire management and control of the institution. Under this Act the Museum has continued to be and is still administered.

In happy contrast to the untoward fate of too many kindred institutions, the South-African Museum has from the first been most fortunate in the possession of trustees who were men of culture and of scientific attainments; and for fifteen years it enjoyed the further advantage of the services of Mr. E. L. Layard, C.M.G. (now H.M. Consul in New Caledonia), as its Curator.

The usual difficulties attended the acquisition of suitable premises for the Museum, but these were eventually obviated by the erection at the cost of the public of a building expressly designed for the purpose; and on April 5, 1860, the Museum was opened to the public in its new quarters.

As mentioned in our notice already referred to, the Cape Museum appears, notwithstanding the advantages stated, to have suffered from the chronic complaint of very insufficient funds. The system of support partly from the Colonial Treasury, and partly from private subscriptions, seems to have failed, the subscribers lost by death or departure from the Colony not being as a rule replaced by others; and of late years the institution depended almost wholly on the government subsidy of 300*l.* With such limited means at their disposal, it was obviously out of the question for the Trustees to award an adequate remuneration to the Curator, and they had no alternative but to make shift with engaging the services of a gentleman willing to devote a part of his time to the Museum. This unsatisfactory state of things has now been remedied by the government on the recommendation of the Trustees, constituting the Curatorship a Civil Service appointment, with a suitable salary. We congratulate Mr. Trimen—who has been for four years endeavouring to satisfy simultaneously the rival claims on his attention of an ordinary public office, and of a museum of natural history—upon his appointment to the Curatorship on its improved basis; and we consider that great credit attaches to the Cape Government for effecting so desirable a reform. We must not omit to mention, moreover, that, under further legislative provision, a new gallery has just been erected in the Museum, and other much-needed repairs and improvements in course of execution are approaching completion.

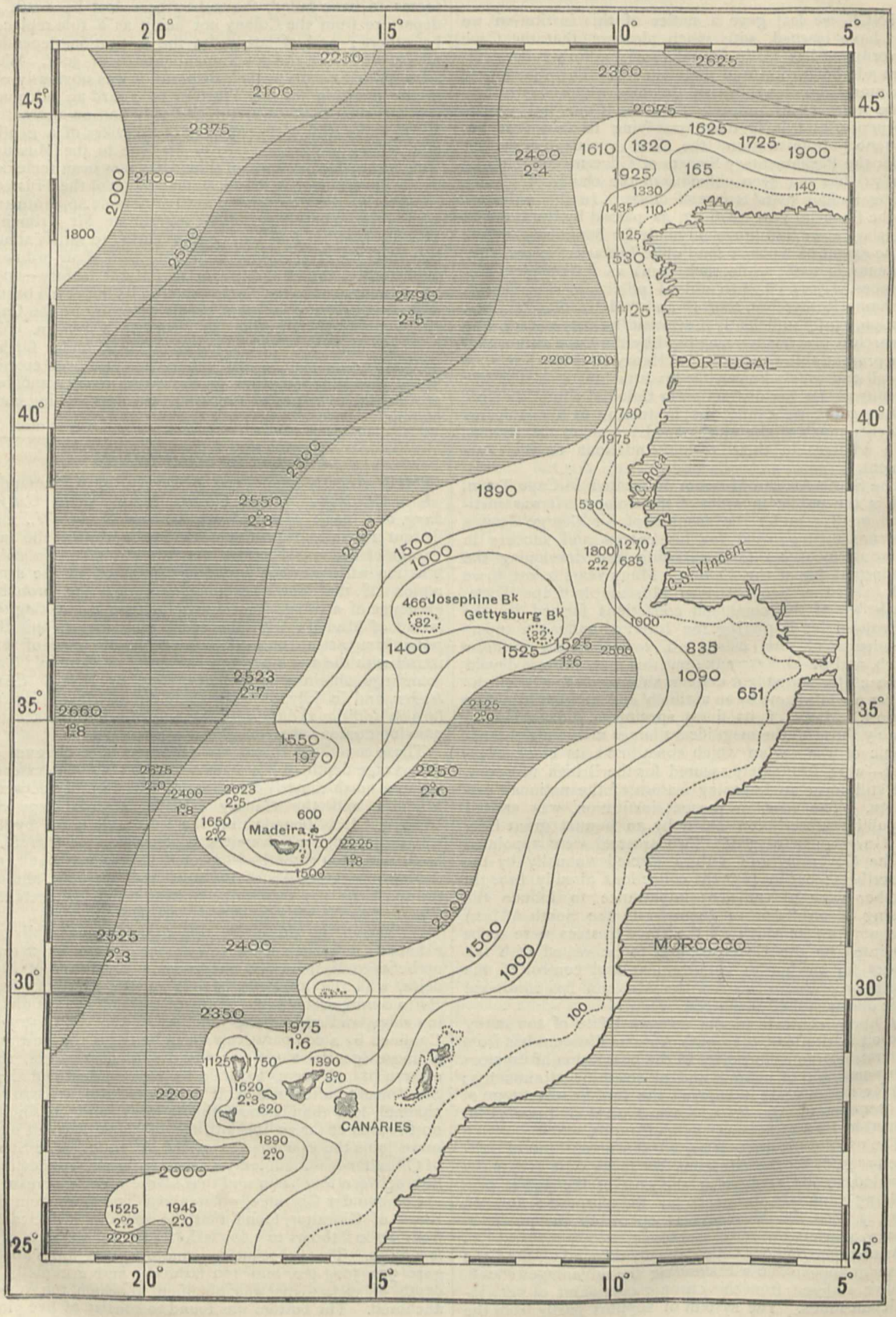
ATLANTIC SOUNDINGS

THE recently-announced discovery by Commander Gorringe, of the United States sloop *Gettysburg*, of a bank of soundings bearing N. 85° W., and distant 130 miles from Cape St. Vincent, during the last voyage of the vessel across the Atlantic, taken in combination with previous soundings obtained in the same region of the North Atlantic, suggests the probable existence of a submarine ridge or plateau connecting the island of Madeira with the coast of Portugal, and the possible subaerial connection in prehistoric times of that island with the south-western extremity of Europe. The soundings obtained in January, 1873, by H.M.S. *Challenger*, and in July, 1874, by the German frigate *Gazelle*, furnish additional data, with the help of which the accompanying contour-chart has been constructed.

These soundings reveal the existence of a channel of an average depth of from 2,000 to 2,500 fathoms, extending in a north-easterly direction from its entrance between Madeira and the Canary Islands towards Cape St. Vincent. It is bounded on the west and north by the submarine ridge which unites Madeira with the Josephine bank and the recently-discovered Gettysburg bank, on the east by the coasts of Portugal and Morocco, and on the south by the submarine plateau which connects the Canary Islands with the African continent.

As shown in the chart, this channel is virtually an extension or branch of the still deeper channel which runs up between Madeira and the Azores. The island of Madeira, with the adjacent islands of the Dezertas and Porto Santo, occupies the southern extremity of the dividing ridge, and marks the junction of the two channels. Confined by a comparatively steep bank on the west and a more gentle slope towards the African shore, this eastern branch seems to attain its greatest depth off Cape St. Vincent, after which it contracts into a narrower channel, less than 2,000 fathoms deep, and continuing northwards as far as the latitude of Cape Roca, it once more joins the vast abysses of the Atlantic. The Strait of Gibraltar is undoubtedly a recently-formed connecting-link between this basin and that of the Mediterranean.

Commander Gorringe, when about 150 miles from the Strait of Gibraltar, found that the soundings decreased from 2,700 fathoms to 1,600 fathoms in the distance of a few miles. The subsequent soundings, five miles apart, gave 900, 500, 400, and 100 fathoms, and eventually a depth of 32 fathoms was obtained, in which the vessel anchored. The bottom was found to consist of live pink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125
1530
1125
2200
2100
PORTUGAL
780
1975
C. Roca
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2550
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1000
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C. St. Vincent
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Gettysburg Bk
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Madeira
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1945
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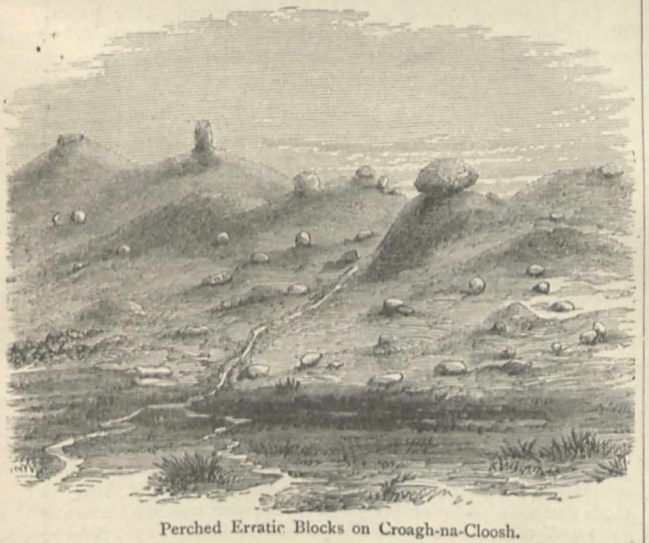
coral, and the position of the bank in lat. 36° 29′ N., long. 11° 33′ W. In other words, Commander Gorringe, on his journey westward from the Strait, after passing over the northern extremity of the deep channel, sounded up the steep slope of the submarine plateau which connects Portugal with Madeira, and within a short distance of a sounding of 1,525 fathoms obtained by H.M.S. *Challenger* on January 30, 1873, in lat. 36° 23′ N., long. 11° 18′ W.

The sketch-map does not pretend to be more than an approximation founded upon the still limited number of soundings obtained up to this date, but the bottom-temperatures observed in this part of the North Atlantic tend to corroborate the views which I have ventured to express. They show that the submarine flow of cold water of antarctic origin, which has been traced as far north as the Bay of Biscay, also fills up the lower depths of the channel which stretches up towards Cape St. Vincent. On the other hand, the channel between the coast of Portugal and the Gettysburg Bank is occupied by the warm water of the Gulf Stream return-current, which, spreading itself out over the banks to westward, explains the presence of the live coral found by Commander Gorringe.

JOHN JAMES WILD

HUMMOCKY MORAINE DRIFT

DURING his survey of the West Pacific slopes, Clarence King found and has since described, hummocks of moraine drift on the "dying-out glaciers," which are somewhat similar to the "hog-wallows;" and J. le Conte has described dying-out glaciers and moraine drifts of California. Abstracts of these descriptions will be found in the *American Journal of Science and Arts*, and the full description of the West Pacific



Perched Erratic Blocks on Croagh-na-Cloosh.

slopes in Clarence King's report. In West Galway, Ireland, there are in places large tracts of drift sometimes like Clarence King's description, in others like the "hog-wallow;" that in the Memoirs of the Irish branch of the Geological Survey have been described as "rocky moraine drift." The accompanying sketch is of some of these drift hummocks on the north slope of Croagh-na-Cloosh, south of Oughterard.

G. H. KINAHAN

CONTRACTION OF THE LEAF OF "DIONÆA MUSCIPULA" [1]

IN the first section of this paper the authors give an account of the mechanical effects which ensue on exciting the sensitive hairs of the Dionæa leaf. The following is a *résumé* of the principal conclusions at which the authors have arrived :—

[1] Abstract of paper on the Mechanical Effects and on the Electrical Disturbance consequent on Excitation of the leaf of *Dionæa muscipula*, by J. Burdon-Sanderson, M.D., F.R.S., Professor of Physiology in University College, and F. J. M. Page, B.Sc., F.C.S. Read before the Royal Society, December 14, 1876.

If the sensitive hair of a vigorous leaf be touched with very great care by a camel-hair pencil, no visible effect on the leaf will be produced, and a similar gentle contact can be repeated several times before the leaf begins to answer to the excitation by any movement. Sooner or later, however, the marginal hairs bend inwards and the lobes slightly approach each other. The first effectual excitation is followed by an almost imperceptible movement; after this each successive approach of the lobes in nearly every case exceeds that of its predecessor. The interval which elapses between excitation and effect diminishes as the extent of the effect increases, both facts having the same meaning, namely that in the plant, as in certain cases well known to the animal physiologist, inadequate excitations, when repeated, exercise their influence by what has been termed "summation," and thus the last contraction, that by which the leaf closes, is the result of the summation of the excitation which immediately preceded it with all the previous excitations. After the leaf has closed it still contracts at each excitation, and attempts to clench itself with greater and greater force. The interval between an excitation and the resulting movement varies from two to ten seconds.

The authors next proceed to a consideration of the electrical condition of the leaf in an unexcited state, which has recently been made the subject of a minute investigation [1] by Prof. Munk, of Berlin, who has found—1. That if we conceive the external surface of the leaf divided into strips by parallel lines crossing the midrib nearly at right angles, and coinciding with the veining, any point of the external surface of each strip is negative to any point nearer the midrib. 2. That in comparing different points of the midrib with each other, there is one whose position is two-thirds of the distance from the near to the far end of the midrib, which is positive to the rest. 3. He has further stated that the potential of any point on the internal surface of the lobe is exactly equal to that of the corresponding and opposite point on the external surface. Of these three proportions the first two are confirmed, in the main, by the authors of the present paper; as regards normal leaves, however, they take exception to his conclusions on the two under-mentioned points—(*a*) That although there is a spot of greatest positivity on the midrib, more or less corresponding in position to that mentioned by Prof. Munk, yet its position is by no means so definite as Prof. Munk states, but varies in different leaves. (*b*) That the different points in his isoelectrical negative line are never found to be absolutely identical. From the third proposition the authors generally express their dissent. They, however, content themselves for the present with stating two general conclusions—1. That the part of the midrib which lies nearest the two central sensitive hairs is positive to every other part of the external surface of the leaf, but has usually the same potential as the petiole and other inactive parts of the plant. 2. That the external surface, so long as the leaf is in vigour, is always positive to the internal surface.

The method used in this research differs from that generally employed in previous investigations, relating to animal or plant electricity, in two important particulars:—1. In the adoption of Lippmann's electrometer [2] (which has already been used by Prof. Marey in investigations on animal electricity) as the instrument for observing the electrical changes. 2. In the substitution of a constant for a variable potential as a standard of comparison with the potential under investigation.

In comparing the potentials of two points the following arrangement was usually adopted :—The pot containing the plant [3] had been previously kept plunged in water. Three non-polarisable electrodes were used, by one of them (the "fixed electrode") the damp surface of the pot is connected with the gas-pipes of the building, the other two ("movable electrodes") are in contact with the two points under observation. By means of a switch, either of these two movable electrodes can be brought into connection with one end of the electrometer, the other end being connected with earth.

When the whole of the outer surface of a leaf is covered with a mass of kaolin, moistened with salt-solution, and brought into connection with one end of the electrometer, the other end being connected by means of the fixed electrode with the petiole or pot, the effect of exciting a sensitive hair is to produce an

[1] Reichert's and du Bois-Reymond's Archiv, 1876.

[2] See the original paper, or Lippman, *Pogg. Ann.*, 1873, **149**, 546.

[3] Most of the observations were made at Kew in the month of August, 1876, the plants being obtained from the Royal Gardens, through the kindness of the Director.

"excursion" indicating a change of potential *in a negative direction* at the movable contact amounting to 3·5 to 5·0 *d* $\left(d = \frac{1 \text{ De La Rue element}}{100}\right)$.

If a similar plug is applied to the internal surface, so as to cover the whole of it, the result is the same, but the extent of the excursion is somewhat less. Hence it may be generally stated that during the electrical disturbance *the surface of the leaf becomes more negative*[1] *as compared with any other surface of which the potential is constant*, and that on the external surface the change is greater than on the internal. This electrical disturbance is limited to the leaf and ceases at the point dividing the petiole from the isthmus or bridge, by which it is united with the leaf; on the petiole side of this point no sign of electrical disturbance is shown by the electrometer.

For various reasons the authors determined to direct their attention to the middle third of the leaf. The following were selected as representative points of contact:—(1) a point (*i l*) on the internal surface of the leaf equidistant from the three sensitive hairs; (2) a point on the external surface (*e l*) exactly opposite to *i l*; (3) and (4) points on the internal (*i m*) and external (*e m*) surfaces of the midrib, where the line joining the points *i l* on either lobe cuts the midrib; (5) the petiole (*p*); and (6) the bridge or isthmus (*b*) already mentioned. The letter P denotes the potential at any point, and V the variation of the potential during the electrical disturbance.

In four leaves the potentials and variations of the external surfaces of the midrib and lobe were severally in hundredths of a De La Rue cell:—

em P as compared with *p* P ...	0	0	0	0
el P ,, *p* P ..	16	0	0	16
em V	−5·0	−6·5	−4·2	−4·5
el V	−2·0	−6·5	−4·0	−4·0

The external variation is usually greater than the internal of a corresponding point, and the variation at *e m* is usually greater than that at any other point; thus in six leaves—

el V =	−3·6	−4·0	−4·2	−4·0	−4·0	−4·5
il V =	−1·5	−1·7	−1·6	−1·8	−2·2	−2·2

and

im V =	−3·0	−3·5
em V =	−5·5	

When a leaf is excited at intervals of a minute or oftener by single shocks from a du Bois-Reymond's induction coil,[2] which are of just sufficient intensity to produce a response, it invariably happens that after a time the electrical variation ceases. The variation can be reproduced either by (1) shifting the needle-points to a fresh spot, (2) by increasing the strength of the induction-current, or (3) by allowing the leaf to rest for a longer interval. With relation to electrical stimuli, it is shown that the excitability of the leaf resembles that of the terminal organs of the higher animals, in this respect, viz., that *relatively feeble* stimuli, if applied at very short intervals and repeatedly, are competent to elicit a response.

If a leaf be excited at short intervals by faradisation, the excitations (makes *and* breaks) being continued each time until an excursion is produced, the combined effects of summation and gradually increasing exhaustion can be readily observed. At first the leaf responds after eight to ten excitations, but gradually the number of excitations required to awaken the tissues to action increases, the effect being postponed for longer and longer periods, until it finally fails to occur. When a leaf is excited at regular intervals by single shocks of such intensity as to be just beyond the limit of adequacy, the effects sometimes become rhythmical.

The time which intervenes between an excitation and the beginning of the electrical disturbance varies in different leaves, and is very much affected by variations of temperature. This time the authors have called the *period of electrical delay*.

As a mean of many experiments it was found that when the fixed electrode was on the petiole and the movable electrode on *e m*, the *delay* was 0·295 second. If the movable electrode was at *e l* or *i l*, the delay varied according to the proximity of the sensitive hair touched to the point of application of the movable electrode. Thus if the movable electrode was at *e l* and a sensitive hair on the same lobe was touched, the delay was 0·231 sec.; but if a hair on the opposite lobe was touched the delay was 0·403 sec, the disturbance having to make its way from the sensitive hair on the opposite lobe through and across the midrib and up to the electrode. It is obvious that by measuring the distance between the hair touched and the electrode we can ascertain, more or less exactly, the rate of the transmission of what may be called the "wave of negative variation" through the leaf. From many experiments, the stimulation being sometimes mechanical and sometimes electrical, it was found that the wave traversed a distance of about 8 mm. in 0·18 sec., or at a rate of about 4·4 centims. per second. When the *period of delay* at *e l* was compared with that at *i l*, it was found that it was shorter at *e l* than *i l*; *e.g.*, in some experiments (the excitation being weak faradisation and the excursions being taken from *e l* and *i l* alternately), the following numbers were obtained:—

Inside	0·71	0·61	0·68	0·75	0·95 sec.
Outside	0·48	0·50	0·52	0·65	0·49 ,,

Finally, if either *el*, *il*, *em*, or *im* be compared with the bridge *b*, it will be found that the *period of delay* at *b* will be much greater than that at any of the other points;

thus *el*	0·26	0·24	0·12	0·18 sec.
bridge (*b*)	0·87	0·65	0·85	0·83 ,,

In normally active leaves, in which the disturbance is first seen about a sixth of a second after mechanical stimulation, the excursion attains its maximum in about one second, and the whole disturbance is over in about two seconds after the excitation, so that the electrical disturbance is entirely over before the mechanical effect begins, and consequently occurs in a period which in muscle is called the period of latent stimulation.

All these periods are, however, very much modified by temperature, being shortened if the temperature is raised (within certain limits), and lengthened if the temperature falls.

The following is one of several tables given in the paper, illustrating the effect of temperature on the periods of delay, maximum and total duration of the electrical disturbance:—

Time in seconds after excitation.	In leaf at ordinary temperature.	In warm chamber at 45° C.	Cooled by proximity of a block of ice.
To beginning of excursion	0·23	0·11	0·44
To maximum ,, ...	1·40	0 79	1·68
To end ,, ...	2·2	1·37	2·94

THE SPONTANEOUS GENERATION QUESTION[1]

AT the meeting of the French Academy of Sciences on January 29, M. Pasteur read the following reply to Dr. Bastian:—

Dr. Bastian, in reply to the communication which I made on January 8, along with M. Joubert, addressed to the Academy last Monday a long note, in which he still contrives, I think, to elude the main point of the debate. In our communication of January 8 there was one word of prime significance, *pure potash*; but, what is surprising, in the reply of three pages of Dr. Bastian there is not even allusion made to that condition of purity, which was everything.

I shall make a new attempt to recall the English *savant* to the criterion, from which he cannot escape, do what he will.

The discussion was raised by his statement, that a solution of boiled potash caused bacteria to appear in sterile urine at 50°, after it had been added to the latter in quantity sufficient for exact neutralisation. Dr. Bastian concluded that he had thus discovered the physico-chemical conditions of the spontaneous generation of certain bacteria.

This is my reply to the learned London professor of pathological anatomy:—

I defy Dr. Bastian to obtain, in presence of competent judges, the result to which I have referred, with sterile urine, on the sole condition that the solution of potash which he employs be pure, *i.e.* made with pure water and pure potash, both free from organic

[1] Continued from p. 314.

[1] It is interesting to note that the surface of a frog muscle, during the electrical disturbance which precedes contraction, becomes *positive*.

[2] Two steel needles sheathed in glass, and bound together, were used as exciting electrodes, the points of the needles being thrust through the epidermis of the leaf.

matter. If Dr. Bastian wishes to use a solution of impure potash, I freely authorise him to take any in the English or any other Pharmacopœia, being diluted or concentrated, on the sole condition that that solution shall be raised beforehand to 110° for twenty minutes, or to 130° for five minutes.

This is clear enough, it seems to me, and Dr. Bastian will understand me this time.

The following reply to the above was read at the Academy on February 12:[1]—

At the *séance* of January 29, M. Pasteur, in reply to a communication which I had made at the previous *séance*, challenges me to cause sterile urine to ferment by the addition of a suitable quantity of *liquor potassæ*, "on the sole condition that this solution shall be raised beforehand to 110° for twenty minutes, or to 130° for five minutes."

In order that M. Pasteur may not attribute to me the least desire "to elude the main point of the debate," and also with the view of testifying the respect which I consider due to the opinions of so distinguished an investigator, I hastened at once to accept his challenge. During the last week I have repeated my experiments several times, and with a degree of precaution going much beyond the severity of the conditions prescribed by M. Pasteur.

I repeated them at first with liquor potassæ which had been previously raised to *110° C. for sixty minutes*, and afterwards with liquor potassæ which had been raised, in the same manner, to *110° C. for twenty hours*. The results have been altogether similar to those produced upon sterile urine by liquor potassæ, which has been raised only to 100°, when added in suitable quantity; that is to say, *in twenty-four to forty-eight hours the urine was in full fermentation and swarmed with bacteria*. The specimens of urine employed had a specific gravity ranging from 1,020–1,022, and they required about 3 per cent. of liquor potassæ for neutralisation.

If M. Pasteur has found himself unable to renounce his interpretation of my experiments on account of "la preuve manifeste," which I have cited in my last communication (p. 189 of the *Compt. Rend.*), I hope he will frankly accept the disproof of his views furnished by the experiments which I have now the honour of communicating to the Academy, and which have been made in acceptance of his own challenge. These experiments I hope in a short time to repeat before competent judges.

Verbal Reply of M. Pasteur.

I thank Dr. Bastian for having accepted the proposition which I made to him at the *séance* of the 29th of January. In consequence, I have the honour to beg the Academy to appoint a commission to report upon the fact which is under discussion between Dr. Bastian and myself.

I hope that Dr. Bastian will seek to induce the Royal Society of London, of which he is a member, to nominate a commission for the same purpose.

At the *séance* of February 19, it was announced that MM. Dumas, Milne-Edwards, and Boussingault have been appointed to constitute a commission charged to express an opinion on the fact which is under discussion between Dr. Bastian and M. Pasteur.

OUR ASTRONOMICAL COLUMN

THE NEW COMET.—Elements of the new comet calculated by Dr. Hartwig of Strasburg from observations to February 15 are almost identical with those given in this column last week. Observations have been made at Berlin, Copenhagen, Leipsic, Lund, Paris, and Strasburg. On the 16th the comet appeared to the unaided vision a little brighter than the well-known cluster in Hercules, and in the telescope presented itself as a round nebulosity, ten minutes in diameter, with a small central nucleus: this apparent measure corresponds to a real diameter of 77,000 miles.

The following ephemeris for every second midnight, Greenwich time, may facilitate observations. The intensity of light is assumed, as usual, to be represented by the reciprocal of the product of the squares of the distances from the earth and sun: it will be remarked that on the last date, the degree of brightness is only one-sixth of that on the first date of the ephemeris:—

		Right Ascension.	North Polar Distance.	Distance from the Earth.	Intensity of Light.
		h. m.	° ′		
March	3 ...	3 39·5 ...	27 12 ...	0·613 ..	2·06
	5 ...	3 51·1 ...	29 56 ...	0·683 ...	1·59
	7 ...	3 59·5 ...	32 11 ...	0·754 ...	1·25
	9 ...	4 5·8 ...	34 4 ...	0·826	1·00
	11 ...	4 11·0 ...	35 38 ...	0·898 ...	0·81
	13 ...	4 15·2 ...	36 59 ...	0·970 ...	0·67
	15 ...	4 18·9 ..	38 8 ...	1·042 ...	0·56
	17 ...	4 22·2 ...	39 9 ...	1·114 ...	0·47
	19 ...	4 25·1 ...	40 1 ...	1·185 ...	0·39
	21 ...	4 27·8 ...	40 47 ...	1·256 ...	0·34

THE VARIABLE-STAR T CORONÆ BOREALIS.—In No. 2,118 of the *Astronomische Nachrichten*, Prof. Schmidt, of Athens, publishes numerous comparisons of the brightness of this star, the so-called *Nova* of 1866, with a neighbouring star which he satisfied himself is not variable, and finds that during the period 1866-1876 there have been fluctuations of brightness exhibiting a certain regularity, from which he deduces the most probable period 93·7 days. Prof. Schönfeld, at Bonn, has also noted these changes, and has determined the times of maxima at which the star varied from 7·8 m. to 9·0 m. T Coronæ therefore exhibits a similar phenomenon to that already remarked about η Argus, "Nova Ophiuchi, 1848," and the star which is almost precisely in the position of Tycho Brahe's famous object of 1572.

THE RADCLIFFE OBSERVATIONS, 1874.—With the marked regularity which distinguishes the publication of the Oxford observations, the Radcliffe observer has just circulated the thirty-fourth volume of the series, containing the observations made in 1874. The usual contents of the handsome octavo so punctually presented to us by the Rev. R. Main are too well known to require any detailed account here. The heliometer has been chiefly employed, as before, in the measurement of a selected list of double-stars, a number of which were also observed for position with the meridian circle. Observations of shooting-stars in the year 1876 are included in this volume, with the view of placing them early in the hands of those who are interested in the study of meteoric astronomy.

We believe we are correct in stating that the next volume will contain observations of the solar spots, commenced at the Radcliffe Observatory in 1875, and which will therefore be a new feature in the publication.

DUN ECHT OBSERVATORY PUBLICATIONS, VOL. I.—The difficulty of procuring Struve's great work, the "Mensuræ Micrometricæ," has suggested to Lord Lindsay the formation of a summary of the measures of double-stars contained in it in a convenient and portable form, which has been presented to the astronomical world, as the first volume of publications of the Dun Echt Observatory. The positions of the stars are brought up to 1875; in the text Struve's first epoch is given, the subsequent ones being added in foot-notes, or in the case of binaries and other stars frequently observed, in an appendix. The highest and lowest powers used in the measures, the magnitudes and colours of the components, and the page of the original work, where the measures are to be found, are included in the summary.

There can be no doubt that Lord Lindsay's volume will be welcomed by a large number of amateurs, who are interested in double-star astronomy, but to whom Struve's great work is difficult of access, to say nothing of its awkward size for frequent use, when obtained. The transcript and reduction of places from 1826 to 1875, appears to have been made with great care, as we are able to testify from a number of cases examined—including instances where the variation of precession has required to be taken into account. That equal care has been exercised in the correction of the press, is also apparent, and as an admirable specimen of astronomical typography, Lord Lindsay's summary of the "Mensuræ Micrometricæ" is probably unsurpassed.

[1] "On the Fermentation of Urine; reply to M. Pasteur." By M. H. Charlton Bastian.

From the absence of a publisher's name on the title-page, it is to be inferred that it has been Lord Lindsay's intention to circulate his volume privately amongst astronomers; and we know that this has been done to a most liberal extent: still there must be many persons, unknown to the author, who would gladly provide themselves with so unexpected and useful an addition to astronomical literature, and we would suggest whether it might not be desirable to place this volume, which appears to be intended as the precursor of a series, on sale to the astronomical public.

NOTES

THE Italian Scientific Association, or Society of the Forty, has conferred on Sir William Thomson the prize instituted by Carlo Matteucci, for the Italian or foreigner, who, by his writings or discoveries, has contributed most to the advancement of science.

AT the annual meeting of the Geological Society, the Wollaston Gold Medal was presented to Mr. Robert Mallet, F.R.S., and the proceeds of the Wollaston Donation Fund, to Mr. R. Etheridge, jun., F.G.S.; the Murchison Medal to Rev. W. B. Clarke, F.R.S., Sydney, and the proceeds of the Murchison Geological Fund to the Rev. J. F. Blake, F.G.S.; the Lyell Medal and part of the Lyell Fund, to Dr. James Hector, F.R.S., New Zealand, and the balance of the Lyell Fund to Mr. W. Pengelly, F.R.S.; the Bigsby Medal to Prof. O. C. Marsh, F.G.S., Yale College, U.S.

THE total expenditure on the new building at South Kensington for the reception of the Natural History Collections now in the British Museum is stated in the new Civil Service Estimates to have been 206,472*l.* up to September 30 last. A further sum of 36,650*l.* is required to carry on the works up to the end of the present financial year. This amount has been already voted. The proposed vote for the present financial year 1877–78 is 70,000*l.*, leaving the amount of 81,878*l.* necessary to complete the building, the total estimate having been 395,000*l.* We may remark that it is not only in this country that a new Museum of Natural History is in progress. Both at Paris and at Berlin the present buildings for the National Museum are found to be too small, and large sums are to be appropriated to their reconstruction.

THE new Civil Service Estimates also contain an account of the proposed expenditure on the working out of the collections brought home by H.M.S. *Challenger*, which amounts altogether to 4,000*l.* Of this 1,560*l.* is to be devoted to "salaries," 800*l.* to "piece-work," 1,200*l.* to "plates," 240*l.* to "travelling expenses," and 200*l.* to "stores." The salary of the director is to be 500*l.* per annum, that of his chief assistant 400*l.*

IN the Civil Service Estimates for the present year under the head of "British Museum," it will be found that 800*l.* are asked for for acquisitions in the Department of Mineralogy, 800*l.* for Fossils, 1,200*l.* for Zoological, and 400*l.* for Botanical specimens. At the same time it may be noted that the sum of 10,000*l.* is to be devoted to the purchase of printed books, although copies of all books published in the United Kingdom are furnished gratis to the Museum.

PROF. ALFRED NEWTON, F.R.S., has been elected to a Fellowship at Magdalene College, Cambridge.

THE death is announced, at the age of seventy-six years, of Admiral Wilkes, of the U.S. Navy. Probably our readers will better recognise him under the name of Commodore Wilkes, the commander of the well-known U.S. exploring expedition of 1838-42, the results of which were of great scientific importance. Wilkes was the author of a work on the Theory of Winds. He was the same Wilkes who, by his conduct in the Mason and Slidell incident of the American civil war, nearly caused war between this country and the United States.

POGGENDORFF'S *Annalen* will be continued under the editorship of Prof. G. Wiedemann, in Leipsic, who is already the editor of the supplement (*Beiblätter*), and Prof. Helmholtz will join him in his new task. The old staff of contributors have declared their willingness to continue the publication of their researches in the *Annalen*.

AT the Royal Geographical Society on Monday, papers were read "On his recent journey to Lake Nyassa," by Mr. E. D. Young, R.N., and an "Examination of a route for wheeled vehicles between the east coast of Africa and Ugogo," by the Rev. Roger Price.

MR. L. HEILIGBRODT, of Bastrop, Texas, has been engaged since 1867 in making collections of the reptiles and insects of that district.

PROF. KUNDT has been chosen Rector of Strassburg University for this year.

PROF. SCHWENDENER, of Basel, has been called to the chair of the late Prof. Hofmeister, of Tübingen.

WE learn from Helsingfors that M. Henez has returned from his travels in Russian Lapland. He has been studying the little-known language of the Lapps on the Murmansk peninsula. Besides a collection of interesting ethnological data, he has brought with him a complete translation of the Gospel of St. Matthew, which, we believe, will be published by the English Bible Society in Russian type.

WE notice an interesting Russian monograph by M. Malieff—"Anthropological Sketch of the Bashkirs,"—which has appeared in Kazan. The author, who was sent to the Orenburg Government by the Kazan University, to collect skulls of Bashkirs, and spent some time among this people, gives a number of anthropological measurements of men, statistics as to births, and various interesting information on the present state of the Bashkirs, their rapid increase, their customs, religion, &c., and discusses their future prospects.

THE *Golos* announces that the Moscow Society for Promoting the Development of Russian Marine Trade will continue next year the exploration to the Gulf of the Obi, and also build some vessels for exporting, in 1878, various merchandises from the Obi into Europe, especially of ship-building wood to England. M. Dahl, a teacher at the Gainag Marine School in Livonia, with some of his pupils, will be intrusted with this task.

SOME difficulties have been met with in the advance of Potanin's expedition in Western Mongolia. When passing by the convent of Shara Sumson the members of the expedition were assailed by the monks, and student Posdnéeff and the interpreter received severe injuries. Nevertheless, Potanin continues to advance into the interior of the country.

THE occurrence of gold disseminated in small quantities through the older geological formations of Australia has been known for many years. But Mr. C. S. Wilkinson, of the Geological Survey of New South Wales, has observed what seems to be a new fact, that gold in sufficient quantity to be worth mining, occurs in a conglomerate belonging to the Coal-measures, and that the alluvial gold of the Old Tallawang diggings has been derived from the waste of these conglomerates. He justly points out that, apart from the scientific interest belonging to so venerable an auriferous alluvium, considerable commercial importance attaches to its discovery, seeing that the conglomerates may now become a new source of supply for the precious metal. At Clough's Gully the actual conglomerate is now being worked, and yields from 1 dwt. to 15 dwts. of gold per ton, and nuggets sometimes weighing 5 ounces.

PROF. W. H. FLOWER, F.R.S., will commence his course of Hunterian Lectures at the Royal College of Surgeons in Lincoln's Inn Fields, on Friday, March 9. The lectures, nine in number, will be delivered on Mondays, Wednesdays, and Fridays, at four o'clock, the subject being "The Comparative Anatomy of Man." From the prospectus, we learn that after treating of the variations in the human external, dental, and osteological characters, Prof. Flower will discuss the methods of estimating the capacity of the skull, craniometry, and the peculiarities of the brain. It is worthy of remark that anyone anxious to attend these lectures, if not connected with the College, will be allowed to do so upon application for a card of admission.

THE Association of German naturalists meets at Munich on September 18, and not in February, as stated in a recent number.

WE are glad to be able to state that a final settlement has been arranged between Mr. Floyd and the trustees of the late Mr. Lick's legacy on the one hand, and Mr. Lick, the son of the testator and the other relatives on the other. After a deduction of about 200,000 dollars the whole of the estates will be reserved for the ends proposed by Mr. Lick, the father. The sum so secured for scientific purposes amounts to a little less than three million of dollars.

THE French Society of Aërial Navigation has published a circular stating that owing to internal difficulties the meetings are suspended up to May 1. Another society was established by French aëronauts—who escaped from Paris by balloon during the siege—last April and is called the School of French Aëronauts. They confine themselves to practical ends, devoting themselves exclusively to the use of balloons for scientific purposes.

A NEW aëronautical periodical, *l'Aerostat*, has been published in Paris by M. Achille Rouland, secretary of the School of French Aëronauts. It is to appear three times a month, and to contain a summary of all aëronautic news.

The Denstonian is the name of a journal published as the organ of St. Chad's College, Denstone, Uttoxeter. It devotes some space to natural history.

"GEOLOGICAL Time" was the subject of the presidential address of Mr. T. Mellard Reade to the Liverpool Geological Society, and which has been published in a separate form.

NEWMAN'S *Entomologist* now appears as *The Entomologist*, and several new features have been added which will increase its scientific value.

A SPECIAL committee, intrusted with the elaboration of a scheme for the representation of Russian gardening at the Paris Exhibition of 1878, has been appointed by the Russian Society of Gardening.

BY order of the Lord President of the Council, a letter, written by Mr. Andrew Murray, on Injurious Insects has been sent to the Secretaries of the Agricultural Societies of England, Scotland, and Ireland. Mr. Murray proposes a method of stamping out these insects which is worthy of being tried.

DR. PETERMANN has just published an index to his *Mittheilungen* for the period between 1865–1874. This will be of great value to geographers, and its value is much enhanced by two most ingeniously-constructed index-maps which show the various parts of the earth that have been mapped in the *Mittheilungen* during that period, and in a simple way indicate where the map will be found. Besides a general index-map there are maps of the various Continents and of the Arctic and Antarctic regions. By differently coloured lines the scale of the special map referred to is shown, as also its character, whether outline, topographical, physical, or geological.

A MEMORIAL to Lomonosoff, erected in the square of the University of Moscow, was unveiled on the anniversary-day of the University, January 24. The memorial, which was erected at the very moderate cost of 225*l*., collected among professors and students of the Moscow University (founded by Lomonosoff in 1755), is very modest. It consists of a small bust placed on a high very plain pyramidal pedestal bearing the inscription: "To Lomonosoff—the Moscow University: year 1877." In an address by M. Solovieff, Professor of History, he briefly sketched the impulse given to science in Russia by Lomonosoff, and insisted especially on the importance of his works in the development of the history of his nation. No reference was made to the task performed by Russia's first physicist. We are glad to take this opportunity to say that it is a great pity that the Russian learned societies have not yet published a collection of the works of Lomonosoff, all the more as many of his writings, dispersed in rare old periodicals, are now totally unknown or forgotten. This neglect induces us to think that Russian men of science have not yet fully appreciated the depth and width of the physical conceptions of this remarkable physicist of the past century, who not only devoted his time to the study of the most important questions of astronomy, physics, and physical geography (as, for instance, the transit of Venus, the existence of ascending warm currents in the atmosphere), but also in a now forgotten, but able paper on the Arctic Seas, expressed himself very explicitly as to heat being but a mode of motion. We think, therefore, that a complete edition of Lomonosoff's works would be not only an addition to the glory of the science of the eighteenth century, but also a most interesting acquisition for all those who are interested in the history of science.

A PARTY of the Swiss Alpine Club have availed themselves of the prevailing mild weather to extend their yearly winter excursion in the mountains as far as the Col de Balme. They crossed the mountain-pass on January 21, and, after many pleasant adventures, reached the hotels of the Col, which were so deeply buried in snow that the way to the rooms had to be made through the windows of the first floor. Other parties, of French and Swiss excursionists, visited about the same time the renowned archæological ground lying in the Jura between Montbelliard and Porrentruy. The special aim of the excursions was to organise a scheme for a thorough exploration and a detailed survey of these localities to be undertaken next summer. If we take into account the immense number of caves, rocky *abris* (shelters), tumuli, grave-walls, open dwelling-places, and megalithic stones scattered over this part of the Jura, and the strange anomalies observed in the geographical distribution of these remains of prehistoric man (only caverns and rocky *abris* being known in the Swiss part of the Jura, whilst the French part abounds with all kinds of remains enumerated above), we cannot but hope that an exploration of these localities will result in valuable contributions to prehistoric archæology.

A NEW form of marine sounder has been described to the French Academy by M. Tardieu. It consists of a spherical envelope of caoutchouc, a few centimetres in thickness, communicating with an iron reservoir by means of a tube of small diameter fitted with a valve. The caoutchouc envelope being filled with mercury, any increase of the exterior pressure makes a certain quantity of mercury pass into the iron reservoir, whence, however, it cannot return. When the apparatus has been lowered in deep water, the weight of the mercury found in the reservoir enables one to determine the pressure to which it has been subjected, and therefore the depth.

M. FELIX PLATEAU read, at a recent meeting of the Belgian Academy, a paper giving an account of the journeys of a large number of Belgian naturalists during the last two centuries. This paper is now published separately (Hayez, Brussels), and contains much important information.

THE Russian Government having refused to enact a law by which all the *koorgans*, or ancient and prehistoric grave-mounds, so numerous in Russia, would be proclaimed the property of the state, a private society is now in way of formation for the same purpose. The society proposes to enter into negotiations with proprietors of land for receiving from them grants of property on the *koorgans*, and to undertake afterwards a series of systematical explorations of these mounds.

THE *Denver News* states that after a severe snowstorm on the night of December 22, 1876, the sun, next morning, rose clear, but the air was filled with particles of frost, the refraction from which caused the appearance of "mock suns" or "sun dogs." First, extending from the sun right and left was a circle entirely around the heavens. Along it were the "sun dogs" in their usual places, with extra ones in the north-west, south-east, and south-west, being directly opposite the sun and at right angles to that line. A very bright circle, like a continuous rainbow, surrounded the sun, at an angle twenty or thirty degrees from it, and crossing the horizontal circle at the most brilliant of the false suns. Another and similar circle, and of about the same diameter, occupied the zenith. Thus there was a complete circle around the horizon, and twenty to thirty-five degrees above it two complete rainbow circles of exceeding brightness and seven "mock suns" or "sun dogs." The spectacle lasted, with changing effects, for two hours or more.

AUSTRIAN census statistics show that cretinism is prevalent to a great extent in the more mountainous portions of the empire. The proportion in 10,000 inhabitants is 40 in the Salzburg district, 18·3 in Upper Austria, 17 in Styria, 10 in Silesia, 7·6 in Tyrol, &c. As yet no institution has been provided by the state for the reception of the unfortunate victims.

A SERIES of measurements of the calorific intensity of solar radations and of their absorption by the terrestrial atmosphere, has been lately made by M. Crova. His mode of observation is described in the December number of the *Journal de Physique*. He has ascertained that the law of transmission of radiations may be represented by an expression of the form $y = \frac{Q}{(1+ax)^b}$, in which y represents the calorific intensity of radiations which have traversed an atmospheric thickness equal to x; Q is the solar constant which, in the author's experiments, is represented by values generally superior to two units of heat received per minute on a square centimetre; a and b are two numerical constants determined by the position of tangents to the curve drawn at different points. The coefficient of transmissibility of the radiations through an atmospheric thickness equal to unity varied, in the circumstances in which M. Crova measured it, between about 0·940 and 0·800, according as the atmospheric thickness already traversed was more or less considerable.

MINERALOGISTS have often been troubled to distinguish with certainty between apatite and nephelin. A. Streng communicates in the last *Mineralogischen Mittheilungen*, a simple but secure method for overcoming this difficulty. If a drop of a concentrated solution of ammonium molybdate in nitric acid be placed on a thin section of an apatite crystal under a microscope, the observer notices quickly the formation of a circle of small yellow crystals of $10MoO_3 + PO_4(NH_4)_3$, either in the form of regular octahedrons or of regular rhombic dodecahedrons. A second test is the following. If a drop of sulphuric acid be added to a section which is already partially dissolved in nitric acid, the formation of crystals of gypsum is easily noticed. Nephelin yields negative results in both cases; a positive test for its presence consists in the addition of a drop of hydrochloric acid to a thin section under the microscope. After the lapse of a few minutes the formation of numerous small colourless cubes of sodium chloride is quite perceptible. They result from the decomposition of the silicate of sodium by hydrochloric acid, and the insolubility in the latter of the salt thereby formed.

THE *Bulletin* of the Belgian Academy of Science (vol. 42, Nos. 9 and 10) contains the second part of an interesting memoir by M. J. Plateau, "On Accidental or Subjective Colours." The author had advanced, in 1834, a theory for the explanation of the subjective colours, and especially insisted on the circumstance that, after having looked some time upon a coloured body, we mostly do not see the true complementary colour, but some other: the orange, for instance, instead of a pure yellow, after the blue; or a violet, instead of the blue, after the yellow. He explained it by supposing, firstly, that the retina, after having received the impression of some colour, comes immediately into such a condition as if it were influenced by the opposite colour, but that this subjective impression soon disappears, and reappears again, alternating with reappearing impressions of the primitive colour of the coloured body; and secondly, that similar phenomena take place also in space, *i.e.*, that the image of the coloured body on the retina is surrounded, firstly, by a narrow strip of the same colour as the body (which phenomenon we call irradiation), and then by a strip of opposite colour, around which, under some circumstances, may reappear a third strip, of the colour of the body looked upon. This theory having been much opposed since its appearance, especially in Germany and England, the author now discusses the various objections advanced against it; those relative to the first part of the theory were the subject of the first part of the memoir (*Bulletin*, vol. 39, 1875), and those relative to its second part are dealt with in this second memoir. The author begins his discussion with the objections against his theory of irradiation, dealing at great length with the opinions and objections of Helmholtz, and treating very skilfully the many difficulties of the whole question, among which the various myopy of the observers seems to be an important one. Further, the author criticises the theories of irradiation advanced until now (the imperfect accommodation of the eye, its spherical and chromatic aberration, and the diffraction at the borders of the pupil), and concludes that the fact that two neighbouring irradiations may mutually neutralise each other, would alone be sufficient to condemn all these theories. The memoir is to be continued.

A COMPARISON has recently been made by Dr. Buff between the indications of the thermomultiplier and the radiometer. The two instruments were placed side by side in the cone of light admitted through an aperture of a board from a gas lamp, which could easily be regulated and kept constant for some minutes. There was a glass disc in front of the thermopile. In the galvanometer the deflections of the needle were proportional to the deflecting force up to 21°. On tabulating deflections and numbers of rotations, it appears that their product is very nearly a constant number, warranting the inference that *the velocity of rotation of the little wheel is inversely proportional to the heat action of the penetrating rays*. This confirms the view that the turning of the radiometer is due to an action of heat rays which penetrate the glass. "If the radiometer," says Dr. Buff, "is incapable of measuring a mechanical force of light, it none the less wears its present name with full right. It is a special form of thermometer, only exclusively for heat rays of high refrangibility, whose heating force is proportional to the velocity of rotation of the wheel."

THE additions to the Zoological Society's Gardens during the past week include a Mauge's Dasyure (*Dasyurus maugæi*) from Australia, presented by Mr. Robert S. Craig; a Slender-billed Cockatoo (*Licmetis tenuirostris*) from Australia, presented by Mr. Bartle G. Goldsmid; a Chilian Sea Eagle (*Geranoaëtus aguia*) from South America, presented by Mr. C. Clifton; a Levaillant's Amazon (*Chrysotis levaillanti*) from Mexico, pre-

sented by Mrs. Mathews; a Common Kestrel (*Tinnunculus alaudarius*), European, presented by Mr. W. W. Hughes; a Rough-legged Buzzard (*Archibuteo lagopus*), European, presented by Lady Bunbury; a Passerine Owl (*Glaucidium passerinum*), European, presented by Mr. T. W. Evans; a Burrhel Wild Sheep (*Ovis burrhel*) from India; a Suricate (*Suricata zenik*) from South Africa; two Beautiful Parrakeets (*Psephotus pulcherrimus*) from Australia, deposited; a Common Rattlesnake (*Crotalus durissus*) from North America, purchased.

SCIENTIFIC SERIALS

American Journal of Science and Arts, February.—Astronomical observations on the atmosphere of the Rocky Mountains made at elevations of from 4,500 to 11,000 feet, in Utah and Wyoming Territories and Colorado, by Prof. Draper.—On dinitroparadibrombenzols, and their derivatives, by Dr. Austen (second paper).—On the orbit of the planet Urda (167), by C. H. F. Peters.—Principles of compensation in chronometers, by J. K. James, M.D.—Notes on the Vespertine strata of Virginia and West Virginia (concluded), by W. M. Fontaine.—On the chemical composition of the flesh of *Hippoglossus americanus*, by R. H. Chittenden.—Notice of Darwin on the effects of cross- and self-fertilisation in the vegetable kingdom, by Asa Gray.—Note on *Microdiscus speciosus*, by S. W. Ford.—On watercourses upon Long Island, by Elias Lewis, jun.

Poggendorff's Annalen der Physik und Chemie, No. 12, 1876.—The ball supported on a jet of water, by M. Hagenbach.—On fluorescence, by M. Lommel.—Electromagnetic properties of unclosed electric currents (concluded), by M. Schiller.—The thermomultiplier as a meteorological instrument, by M. Buff.—On the temperature of the electrodes in induction sparks, by M. Herwig.—On an analogy of chromoxide to the oxides of the cerite metals, by M. Wernicke.—On the theory of condensers, by M. Aron.—On the ratio of cross-contraction to longitudinal dilatation in caoutchouc, by M. Röntgen.—On electrical figures in solid insulators, by M. Holtz.—On the work to be done in evacuation of a given space, by M. Kolâçek.—Contributions to history of natural sciences among the Arabians, by M. Wiedemann.—A historical note on Daniel Bernouilli's gas theory, by M. Berthold. [With this number is issued No. 1 of the *Beiblätter*. It contains twenty-five abstracts of various physical researches that have recently been published.]

THE *Naturforscher* (December, 1876) contains the following papers of interest:—On the action of capillary tubes upon mercury, by E. Villari.—On the influence of water upon the temperature of the soil, by E. Wollny.—On boron, by W. Hampe.—On the determination of the vapour-density of substances having a high boiling-point, by V. Meyer.—On the polarisation of carbon electrodes, by H. Dufour.—On the relation of the organ of sight to the absence or presence of light, by Herr Joseph.—On the age of cells and the protoplasma currents, by Herr v. Vesque Püttlingen.—On symbiotism (the cohabiting of different species of plants), by A. B. Frank.—On the periodic change in the colour of α Ursæ Majoris, by H. J. Klein.—On the dependence of the respiration of plants upon temperature, by Adolf Meyer.—On the frequency of shooting-stars, by J. F. Schmidt.—On the influence of surrounding temperatures upon the circuation of matter in warm-blooded animals, by G. Colasanti.

FROM the *Verhandlungen des naturhistorischen Vereins der preussischen Rheinlande und Westfalens* (32 Jahrg., Part 2) we note the following papers:—Section for geography, geology, mineralogy, and palæontology: on the meteorites of the Natural History Museum of the University of Bonn, by Prof. vom Rath.—On the theoretical conclusions drawn from some observations made in a shaft of 4,000 feet depth at Sperenberg, by Prof. von Lasaulx.—On some fossils from the Neanderthal, by Prof. Schaaffhausen.—On the late volcanic eruption in Iceland and the ashes fallen in Sweden, by Prof. vom Rath.—On the cause of the ice-period, by Dr. Mohr.—On the occurrence of olivine in basalt, by Dr. Mohr.—On the most recent eruptions on the Island of Vulcano and their products, by Prof. vom Rath.—On the systems of volcanic crevasses in Iceland, by Dr. Gurlt.—On an investigation of Westphalian caves, by Prof. Schaaffhausen.—On the occurrence of rock salt in the Keuper formation near Hänigsen, by Dr. Gurlt.—On remains of *Vertebrata* from gravel deposits near Porta (Westphalia), by Herr Banning.—On fulgurites, by Herr v. d. Marck.—On fossil fishes from Sumatra and from Rinckhore, near Senderhorst, by the same.—On the thermal sources of Oynhausen, by Herr Graeff.—On the origin of and changes in Downs, with special reference to those of the German coasts of the North Sea, by Herr Borggreve.—On the geology of Eastern Transylvania, by Prof. vom Rath. Botanical Section: On dichogamy and the conditions regulating the production of blossoms in plants which bear fruit periodically, by Herr Borggreve.—On the formation of the primordial tube, by Herr Pfeffer.—On the production of high hydrostatical pressure through endosmotic action, by the same.—On the fruit of *Hura crepitans*, by Herr Andrac. Section for Anthropology, Geology, and Anatomy: On the palates of *Ptenoglossa*, by Prof. Troschel—On a luminous beetle of the *Physodora* family from Java, by Herr Moknike.—On the fertilisation of the ova of *Araneida*, by Herr Bertkau.—On a stone sarcophagus found near Sechtem (on the Cologne-Bonn railway), containing well-preserved red hair of reddish tint, by Prof. Schaaffhausen.—On the various views of different naturalists on the reproduction of eels, by Prof. Troschel.—On the so-called *Cribellum* of L. Koch, by Herr Bertkau.—On some rare and remarkable *Arachnida* of the Rhenish fauna, by the same.—On stone implements and other objects found in the Klusenstein and Martin's Caves, by Prof. Schaaffhausen. Section for Chemistry, Technology, Physics, and Astronomy: On the separation of ethyl-bases by means of oxalic ether, by Prof. Wallach.—On converting amides into bromides, by V. von Richter.—On indium, by the same.—On some experiments with hydrobenzoines, by Herr Zincke.—On an apparatus for measuring very small fractions of time, by Herr Gieseler.—On a new electro-dynamical law, by Prof. Clausius. Physiological Section: On the functions of the spinal cord, by Dr. Frensberg.—On the structure of the tissues of blood-vessels and the inflammation of veins, by Herr Köster.—On santonine poisoning, by Herr Binz.—On the influence of salicylic acid upon the bones, by Herr Koster. The remaining papers are of purely medical interest.

Reale Istituto Lombardo di Scienze e Lettere. Rendiconti, December 28, 1876.—On some differential equations with algebraic integral, by M. Brioschi.—On the electric theory of the radiometer, by M. Ferrini.—On the anti-fermentative action of boric acid, and its application in therapeutics, by M. Polli.—On the *sclerotium oryzæ*, a new vegetable parasite which has devastated many rice-fields of Lombardy and the Novarese during the past year, by M. Cattaneo.—Mildella, a new genus, type of new tribes of Polypodiaceæ.—Graeco-Indian studies, by M. Cantor. Relating to geometry, algebra, astronomy; &c.

Morphologisches Jahrbuch, vol. ii. part 3.—On the structure of the skin and dermal sense-organs of Urodela (Proteus, Menopoma, Cryptobranchus, Salamandra, Triton, Salamandrina), by F. Leydig, four plates.—On the metamorphosis of Echiurus, by W. Salensky, four stages figured.—On the exoskeleton of fishes, by O. Hertwig. Part 1, sixty-eight pages, six plates, relating to Siluroids and Accipenseroids. The placoid scales of Selachians, the dermal teeth of Siluroids, and the dermal scutes of Accipenseroids are shown to be homologous.—Contribution to the morphology of the limbs of vertebrates, by Prof. Gegenbaur.—The most ancient form of the carpus and tarsus of Amphibia, by R. Wiedersheim.

SOCIETIES AND ACADEMIES

LONDON

Royal Society, February 8.—"On the Transport of Solid and Liquid Particles in Sewer Gases." By E. Frankland, F.R.S.

The suspension of vast aggregate quantities of solid and liquid particles in our atmosphere is the subject of daily remark. Cloud, fog, and smoke consist of such particles, and I have repeatedly seen at a distance of a few feet abundance of snow-crystals floating in the air, when the atmosphere was apparently perfectly clear and cloudless by placing the eye in shadow and then looking into the sunshine.

Prof. Tyndall has, I conceive, proved that a very large proportion of the suspended particles in the London atmosphere consists of water and other volatile liquid or solid matter by showing that the heat of boiling water is sufficient to dissipate them. That this is the true explanation of the disappearance of such particles by the application of a moderate degree of heat, and that it is not caused by the rarefied air from the heated body ascending and leaving behind the suspended matter, as suggested by Tyndall is, I think, conclusively proved by experiments in which

I found that suspended particles of sal ammoniac subsided in an atmosphere of hydrogen scarcely twice as fast as in atmospheric air.

Thus an atmosphere fourteen times as rare as that of London (and, as Prof. Stokes remarked, possessing only half the viscosity of air), still offers sufficient resistance to the subsidence of minute suspended particles to prevent them from falling more rapidly than one inch per minute. Such particles could not therefore be left behind by an ascending current of the slightly rarefied but more viscous air produced by an increase of temperature to 100° C.

In addition to these aqueous and other volatile particles which disappear by a gentle heat, there are also others which consist partly of organic and partly of mineral matters. But the organic seem greatly to preponderate in the air of towns, because such air becomes *apparently* perfectly clear after it has been ignited.

The processes of fermentation, putrefaction, and decay afford abundant evidence that zymotic and other living germs are present amongst the organic portion of the suspended matters, whilst many analyses of rain-water, made by myself and others, show that the salts of sea-water are amongst the mineral constituents floating in the atmosphere.

Of the zymotic matters, those which produce disease in man are obviously of the greatest importance. The outbreak of Asiatic cholera in Southampton in the year 1866, for instance, was traced by the late Prof. Parkes, F.R.S., to the dispersion of infected sewage through the air. The sewage became infected by the intestinal discharges from some cholera patients who landed from the Peninsular and Oriental Company's steamship *Poonah*.

In this case the dispersion was produced by the pumping of the infected sewage and its discharge, in a frothy condition, down an open channel eight or nine feet long. The effluvium disengaged from this seething stream was described as overpowering, and was bitterly complained of by the inhabitants of the adjacent clean and airy houses, amongst whom a virulent epidemic of Asiatic cholera broke out a few days after the sewage received the infected dejections. Nevertheless the discharge of the frothy liquid was kept up day and night for about a fortnight, and 107 persons perished. At length a closed iron pipe was substituted for the open conduit; from that day the number of cholera cases diminished, and within a week of the protection of the conduit the epidemic was virtually over.

In this example a potent cause of the suspension of the zymotic poison in the air was obvious, but in the many alleged instances of the propagation of typhoid fever by sewer gases, the condition of dispersion is not so evident. Does the flow of sewage in a properly constructed sewer produce sufficient agitation to disperse liquid particles through the air-space of the sewer? I endeavoured to answer this question by violently agitating a solution of lithic chloride in a glass cylinder three inches in diameter and thirty inches high, with a wooden rod, and ascertaining whether the atmosphere at the mouth of the cylinder became impregnated with the liquid, by testing it with the flame of a Bunsen burner; but no trace of lithium could be detected at the mouth of the jar, even after an agitation much in excess of what would ordinarily occur in a sewer.

There is, however, another kind of agitation to which sewage is subject that may produce a very different result—I allude to the development of gases during the processes of fermentation and putrefaction. It is well known that the bursting of minute bubbles of gas at the surface of an effervescing liquid causes the projection of visible liquid particles into the air to the height of several inches. Such visible particles are seen to fall back again immediately into the liquid; but it appeared to me not unlikely that other particles, too minute to be seen, might be simultaneously projected, and by reason of the smallness of their masses in relation to their sectional areas, might continue suspended in the air for a long time. To ascertain the fallacy or truth of this notion I made the following experiment:—

A quantity of a strong solution of lithic chloride was placed in a shallow basin and acidulated with hydrochloric acid; fragments of white marble were then added, and a paper tube five inches in diameter and five feet high was placed vertically above the basin. So long as the effervescence continued, abundance of particles of lithium were visible in a Bunsen flame held at the upper end of the tube. A tinplate tube three inches in diameter and twelve feet long was now placed in such a position as to bring one of its open ends over the top of the paper tube. The tin tube was nearly horizontal but slightly inclined upwards from the paper tube, so as to cause a gentle draught of air to pass through it, when it was slightly heated externally near its lower extremity. A Bunsen flame placed at the end of this tube furthest away from the effervescing liquid, showed that the suspended particles of solution of lithic chloride were not perceptibly less numerous than at the mouth of the paper tube; neither were they much diminished at the further end of the tin tube when the height of the paper tube was increased to nine and a half feet. There can, I think, be little doubt that these particles, which had thus been carried along by a gentle current of air for a distance of twenty-one feet, would be similarly conveyed to very much greater distances.

The following conclusions as to the behaviour of flowing sewage may be drawn from these experiments:—

1. The moderate agitation of a liquid does not cause the suspension of liquid particles capable of transport by the circumambient air, and therefore the flow of fresh sewage through a properly constructed sewer is not likely to be attended by the suspension of zymotic matters in the air of the sewer.

2. The breaking of minute gas-bubbles on the surface of a liquid consequent upon the generation of gas within the body of the liquid is a potent cause of the suspension of transportable liquid particles in the surrounding air, and therefore when, through the stagnation of sewage or constructive defects which allow of the retention of excrementitious matters for several days in the sewer, putrefaction sets in and causes the generation of gases, the suspension of zymotic matters in the air of the sewer is extremely likely to occur.

3. It is therefore of the greatest importance to the health of towns, villages, and even isolated houses, that foul liquids should pass freely and quickly through sewers and drain-pipes, so as to secure their discharge from the sewerage system before putrefaction sets in.

Linnean Society, February 1.—Mr. G. Bentham, F.R.S., vice-president, in the chair.—Messrs. G. Boulger, Alfred S. Heath, and William Meller, were elected Fellows of the Society.—Mr. A. W. Bennett exhibited, and made remarks on, certain specimens of insects illustrating mimicry; these had been captured in Syria by Mr. N. Godman.—An unusual form of double anemone, and some excessively large oak-leaves gathered near Croydon, were shown by Mr. S. Stevens, and they evoked discussion from the Chairman and other Fellows present.—Sir John Lubbock then proceeded with Part 4 of his contributions on the habits of ants, bees, and wasps. In this communication he illustrated by ingenious experiments his *modus operandi* of testing their faculties, dispositions, habits, &c., by something of a double F apparatus (F), whereby an interval of three-tenths of an inch, either by a drop from above or reaching upwards the distance from below, alone prevented ants from gaining access to a covered glass cell filled with larvæ. They evidently had not the acumen to surmount the three-tenths of open space, although they had for hours before been traversing the route and carrying off larvæ previous to the small gap being made. Industry was conspicuously shown by one specimen, which Sir John used to place in solitary confinement in a bottle for hours, and once for days, but the moment released it commenced its laborious larvæ-gathering propensities. It seems, from other experiments, that ants in difficulties within sight of their companions are by no means always assisted or relieved, other attractions, food and such like, possessing greater interest for them. On putting some specimens under the influence of chloroform, little or no notice was taken of those insensible by their companions, the tendency apparently being to let friends lie and throw over the edge of the board strangers thus chloroformed. It seems that to get ants properly intoxicated with spirit for experimental purposes is no easy matter, some recovering too quickly, and others remaining so thoroughly dead drunk as to come under the rank of impracticables; while between reeling friends and strangers the experimenter finds himself baffled. The sober ants are exceedingly puzzled at finding their friends in such a condition. As a general rule they picked up drunken friends and carried them to the nest, whilst they threw into the water and drowned strangers. In some instances confusion arose, for a few of the strangers were carried to the nest and friends tumbled into the water, but they did not return to the rescue of the friends, though strangers were afterwards expelled from the nest. Sir John expresses surprise that ants of one nest perfectly well know each other. Even after a year's separation old companions are recognised and amicably received, whereas strangers, particularly among the *Lasius flavus*, are almost invariably attacked and maltreated, even when intro-

duced in the mixed company of old friends. Sight cannot be acute; for example, in experiments food was placed on a glass slip a few inches from the nest, the straight road to and from the nest being soon familiar to the ants; but when the food had been shifted only a short distance from its first position it was long ere it was discovered. Indeed they wandered from a few minutes to half an hour in the most extraordinary circuitous routes before finding out the direct road between the nest and food, and *vice versâ*. Slavery in certain genera is a positive institution, the Amazon ants (*Polyergus rufescens*) absolutely requiring slave assistants to clean, to dress, and to feed them, else they will rather die than help themselves, though food be close at hand. A curious blind woodlouse (*Platyarthrus hoffmansegii*) is allowed house room by the ants, it acts as a kind of scavenger, the ants taking little notice of the woodlice, and even migrate leaving them behind. Some new species of Diptera of the family Phoridæ he finds to be parasitic on our house ants; and Mr. Vernal has recently described these interesting forms.—A paper on the aspects of the vegetation of Rodriguez was read by Mr. I. Bailey Balfour, who accompanied as botanist the Transit of Venus Expedition in 1874. It seems that, like the flora of St. Helena, that of Rodriguez has undergone great changes, partly by human and other agencies. It is insular, dry, and temperate rather than humid, and tropical in character. The facies is predominantly Asiatic, though forms of Mascarene type, and even Polynesian and American forms, are sparsely met with. The leaves of many plants Mr. Balfour observed exhibited heteromorphism of a marked kind, and this he described with some fulness, remarking that while as a whole in degree and kind variable, yet among species the leaf variation is pretty uniform.—The fungi of the *Challenger* Expedition (third notice), by the Rev. M. J. Berkeley, and on Steere's collection of tropical ferns, by Prof. Harrington, U.S., were papers announced and taken as read.

Zoological Society, February 20.—Prof. Flower, F.R.S., vice-president, in the chair.—Mr. Osbert Salvin, F.R.S., exhibited a series of drawings taken during Hunter's voyage to Australia in 1788–92, wherein Duke of York Island as it then existed was depicted, together with various objects of natural history.—A communication was read from Prof. Owen, C.B., containing an account of some additional evidence recently obtained of the former existence of extinct birds allied to the genus *Dromornis* in Australia.—Mr. Sclater read a paper on the birds collected by the Rev. George Brown on Duke of York Island and on the adjoining parts of New Ireland and New Britain. Eleven species were described as new to science, amongst which were a new Kingfisher proposed to be called *Tanysiptera nigriceps*, and a new Pigeon to which the name of *Macropygia browni* was assigned.—Dr. G. E. Dobson read a paper on a collection of Bats collected by the Rev. George Brown in Duke of York Island and the adjacent parts of New Ireland and New Britain. Amongst these four were considered to belong to undescribed species, and one of these to a new genus of the Frugivorous Bats, proposed to be called *Melonycteris*.—Mr. Edward R. Alston read a paper on the Rodents and Marsupials collected by the Rev. G. Brown in Duke of York Island, New Britain, and New Ireland. The species, six in number, were either identical with New Guinea forms or nearly allied. For the three new species the names of *Mus browni*, *Uromys rufescens*, and *Macropus lugens* were proposed.—Messrs. O. Salvin and F. Du Cane Godman read the descriptions of a collection of Lepidoptera made by the Rev. George Brown on Duke of York Island and its neighbourhood. The series of Butterflies contained twenty-six genera and forty species, while in that of the Moths eleven genera were represented by fourteen species.—Mr. E. J. Miers read a description of the Crustacea collected by the Rev. G. Brown on Duke of York Island. The collection, with one exception (*Lysiosquilla arenaria*), belonged to the Decapoda, and contained in all forty-four specimens representing sixteen species. Although none of the species were new to science, several were interesting and little-known forms.—Dr. A. Günther, F.R.S., read a paper on a collection of Reptiles and Fishes made by the Rev. George Brown on Duke of York Island, New Ireland, and New Britain. Of nine lizards represented in the collection one was described as new, and of eleven snakes three were considered to be hitherto unknown. Amongst the latter was a new genus and species of Erycidæ, proposed to be called *Erebophis asper*.—Mr. H. W. Bates read a paper on the Coleoptera collected by Mr. George Brown on Duke of York Island, New Ireland, and New Britain. The collection comprised forty-four species, and contained some of the finest species of the New Guinea Fauna. Amongst these were many examples of a new Longicorn, proposed to be called *Batocera browni*, after its discoverer.

Geological Society, February 7.—Prof. P. Martin Duncan, F.R.S., president, in the chair.—James Durham, Herbert William Harrison, William Hutchinson, H. M. Klaassen, Graeme Ogilvie, Joseph William Spencer, and Griffin W. Vyse were elected Fellows of the Society.—The following communications were read:—On the chemical and mineralogical changes which have taken place in certain eruptive rocks of North Wales, by John Arthur Phillips, F.G.S. In this paper the author described the felspathic rock of Penmaenmawr, which has been erupted through Silurian strata, and rises to a height of 1,553 feet above the level of the sea. The rock, which is composed of crystalline felspar with minute crystals of some hornblendic mineral, is fine-grained and greenish grey, divided into beds by joints dipping north at an angle of about 45°, and again divided by double jointings, sometimes so developed as to render the rock distinctly columnar. At the eastern end of the mountain the stone is so close in texture as often almost to resemble chert. In the next two quarries westward the rock is coarser, and its jointing less regular. In the most westerly quarry the stone is generally fresher in appearance, closer in grain, and greener in colour. All these stones are probably modifications of the same original rock. From the chemical analysis of the rocks the author concludes that, supposing them all to have had originally the same composition as the unaltered rock in the most westerly quarry, that at the extreme east of the mountain has lost about 3 per cent of silica, and the others have received respectively an increase of 1·35 and 0·77 per cent. of silica.—On a new species of *Belemnites* and *Salenia* from the Middle Tertiaries of South Australia," by Ralph Tate, F.G.S., Professor of Natural Science in the University of Adelaide. The author noticed the occurrence in deposits of supposed Miocene age in South Australia of a species of Belemnite (*Belemnites senescens*) and a *Salenia* (*S. tertiaria*). These fossils were obtained from Aldenga, twenty-six miles south of Adelaide, on the east coast of St. Vincent's Gulf, where the long series of sea-cliffs contains an assemblage of fossils identical with that of the Murray River beds. The *Salenia* is especially interesting on account of the discovery of a living species of the genus by the naturalists of the *Challenger*.—On *Mauisaurus gardneri* (Seeley), an Elasmosaurian from the base of the gault at Folkstone, by Harry Govier Seeley, F.L.S., F.G.S., Professor of Geography at King's College, London. The author described the skeleton of a great long-necked Saurian obtained by Mr. J. S. Gardner from the Gault of the cliff at Folkestone. The remains obtained included a tooth, a long series of vertebræ, some ribs, bones of the pectoral arch, the femur, and some phalanges, indicating a very large species, which the author referred, with some doubt, to the genus *Mauisaurus* of Dr. Hector, founded upon a Saurian from the Cretaceous formation of New Zealand. He gave it the name of *Mauisaurus gardneri* in honour of its discoverer. A small heap of pebbles was found in the neighbourhood of the ribs, and it was supposed that these had been contained in the stomach of the animal.

Anthropological Institute, February 13.—Mr. John Evans, F.R.S., president, in the chair.—Miss Buckland read a paper on primitive agriculture, in which the value of the study of the subject was explained, as determining migrations, &c., of nations in pre-historic times. It was observed that agriculture could only have been practised by peoples having settled habitats, and was probably carried on then, as often is the case now, by women; that agriculture was and is still unknown to some of the lower races who confine themselves to the cultivation of indigenous roots and fruits, whilst the higher races cultivated the cereals. The origin of the cereals is still obscure, and maize, which has been considered indigenous to the New World, and unknown in Europe before the time of Columbus, was, in the opinion of Miss Buckland (based on the reports of recent travellers in Africa, Madagascar, New Guinea, China, &c.), cultivated by peoples which have never had intercourse with Europeans. In America, China, and Ancient Egypt there are traces of a time anterior to that of the cultivation of the cereals; and a similarity of myths, customs, &c., of China, Egypt, Peru, and Mexico leads to the conclusion that an allied pre-Aryan race introduced cereals into all these countries. In the discussion, Mr. Boyd Dawkins, the president, and others took part.—Mr. H. Hyde Clarke exhibited some weapons from the Amazon River, on which Mr. Franks and others remarked.—Lord Rosehill exhibited a collection of very fine and large flint weapons, objects, &c., from Honduras.

The president, Mr. Blackmore, Mr. Franks, and others spoke on the subject.

Society of Telegraph Engineers, February 5.—Prof. Abel, F.R.S., in the chair.—The paper read was on shunts and their applications to electrometric and telegraphic purposes, by Mr. W. H. Preece. Having briefly explained the laws of shunts, Mr. Preece referred to the use of shunts for measuring purposes as well as to their early employment in practical telegraphy. The author entered minutely into the question of electro-magnetic induction, and gave the results of the experimental investigations on the "extra" current upon which he has been recently engaged. The "extra" current which is received from a simple coil of insulated copper wire being selected as the *unit*, it was shown that by the insertion of a core as well as by varying the quantity of iron in the armature, the strength of the "extra" current might be increased no less than 2,238 times. The means which should be adopted in order to counteract the prejudicial effects of the extra currents upon the speed of working were then described at length, and the employment of electro-magnetic shunts in order to compensate for the *static* induction which proves so troublesome on long lines was also fully gone into.

Medical Microscopical Society, January 19.—Annual General Meeting.—Dr. J. F. Payne, president, in the chair.—The secretary's report for the year 1876 was read.—Twelve papers on important subjects were read during the year, of which four were illustrative of new forms of instruments applicable to medical histology.—The number of members in December, 1876, was 129.—The retiring President (Dr. Payne) then delivered his address, in the course of which he remarked that the Society was passing through a crisis, having outgrown its developmental stage, and that its sphere of usefulness was to be found rather among medical practitioners than among students, for whom it was first intended. After pointing out the special function of the Society to be the study of histology in its relation to medical practice and public health, the speaker passed in review the work done during the past year by the members of the Society.

Victoria (Philosophical) Institute, February 19.—Dr. C. Brooke, F.R.S., in the chair.—Mr. Morshead read a paper on comparative psychology.

BOSTON

Natural History Society.—Mr. Hyatt's important contribution on the life-history of the groups of Ammonites (*Proceedings*, December, 1876) develops and applies in detail to the Stephanoceras group (of which *A. humphresianus* is an important member), his doctrines as to the period in life at which specific peculiarities appear. He endeavours to prove that the species of a group inherit the characteristics of their ancestors at earlier and earlier periods, until they become present even in the very young forms. He further brings forward evidence of the inheritance of old-age or senile characters which forebode the extinction of the group. Thus the successive species of almost all large groups sooner or later inherit the senile features of their ancestors, so as to reproduce them at early stages. Further, there is a broad similarity between the senile characters in different groups.

PARIS

Academy of Sciences, February 19.—M. Peligot in the chair.—The following papers were read:—Meridian observations of small planets, at the Greenwich and Paris Observatories, during the fourth trimestre of 1876; communicated by M. Le Verrier.—The human species, by M. de Quatrefages. An outline of the views published in his new work on the subject.—Remarks of M. Chevreul on a recent note of M. Radziszewski relative to phosphorescence of organic bodies.—Properties common to canals, to conduit pipes, and to rivers with uniform flow (continued), by M. Boileau.—MM. Dumas, Milne-Edwards and Boussingault were appointed a Commission to give an opinion on the matter of discussion between Dr. Bastian and M. Pasteur.—On the air-jet in water, by M. de Romilly. When a steady jet is sent normally against the surface, and the tube gradually withdrawn, there is found a distance at which a smooth pocket, deeper than broad, is made at the surface, showing often a slow rotation, and giving a sound, which is strengthened if the same note be played on the violin. When a jet is sent upwards from an orifice near the bottom of a vessel of water, a spherical air-chamber forms about and under the orifice, becoming the base of an ascending air-column, which base is more than triple the diameter of the orifice. The column suddenly contracts near the orifice, then gradually widens. The author describes some other effects.—On Kepler's problem, by M. de Gasparis.—On orthogonal systems comprising a family of surfaces of the second degree, by M. Darboux.—Memoir on the methods employed for determination of the curves of astronomical objectives, accompanied with tables for abridging the calculation, by M. Martin.—On a means of varying the focussing of a microscope without touching either the instrument, or the object, and without altering the direction of the line of vision, by M. Govi. This is based on the fact that the interposition between objective and object of a medium more refringent than air, with plane parallel sides at right-angles to the axis of the microscope, will cause an apparent elevation of the object represented by $d = e\frac{n-1}{n}$, where d is the elevation produced, e the thickness of the medium, and n its index of refraction relatively to air or vacuum. He uses a vessel of liquid with glass bottom and varies the height of the surface either with a plunger or a communicating vessel.—New process of photomicrography, by M. Fayel. The upper end of the microscope catches in a wooden frame on colonnettes, the aperture of this corresponding with that of a dark chamber which can be placed or removed at will. In this chamber is a moveable plano-convex lens, and through it an image equal to that seen by the eye is thrown on sensitised glass.—On the microscope and the dark chamber, by M. Neyreneuf. This gives some theoretical results from examination of Dr. Fayel's method.—On the manufacture of carbon conductors for the electric lamp, by M. Carré. He reminded the Academy of his own experiments. Moistening carbon-powder with syrups of gum, gelatine, &c., or fixed oils thickened with resins, he gets plastic and consistent pastes very suitable for making carbon points of. Even without other admixture, they give more light than the ordinary carbons, in the proportion of 1·25 to 1.—Study and determination of the principal colouring matters used to falsify wines, by M. Chanal.—On the action of alkaline sulphocyanates on chlorhydrates of alkalies of the fatty series, by M. De Clermont.—Action of electrolytic oxygen on glycol, by M. Renard.—On the discharge of the torpedo, studied with Lippmann's electrometer, by M. Marey. If the discharge of a torpedo, much weakened, be directed into the electrometer, the mercury moves in the positive direction, in a jerky way, progressing always more than it goes back. This shows a striking analogy to the phenomena of muscular contraction.—On the localisation of copper in the system, after ingestion of a salt of this metal, by M. Rabuteau. It would be rash to affirm poisoning with a salt of copper, because eight or even twelve centigrammes of the metal might be found in the liver. Salts of copper are less poisonous than hitherto supposed.—On the first development of a star-fish, by M. Fol.—On the hair of vine-shoots, applied to manufacture of paper, by M. Boutin.—On the reconcilement of moral liberty with scientific determinism, by M. Boussinesq.

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